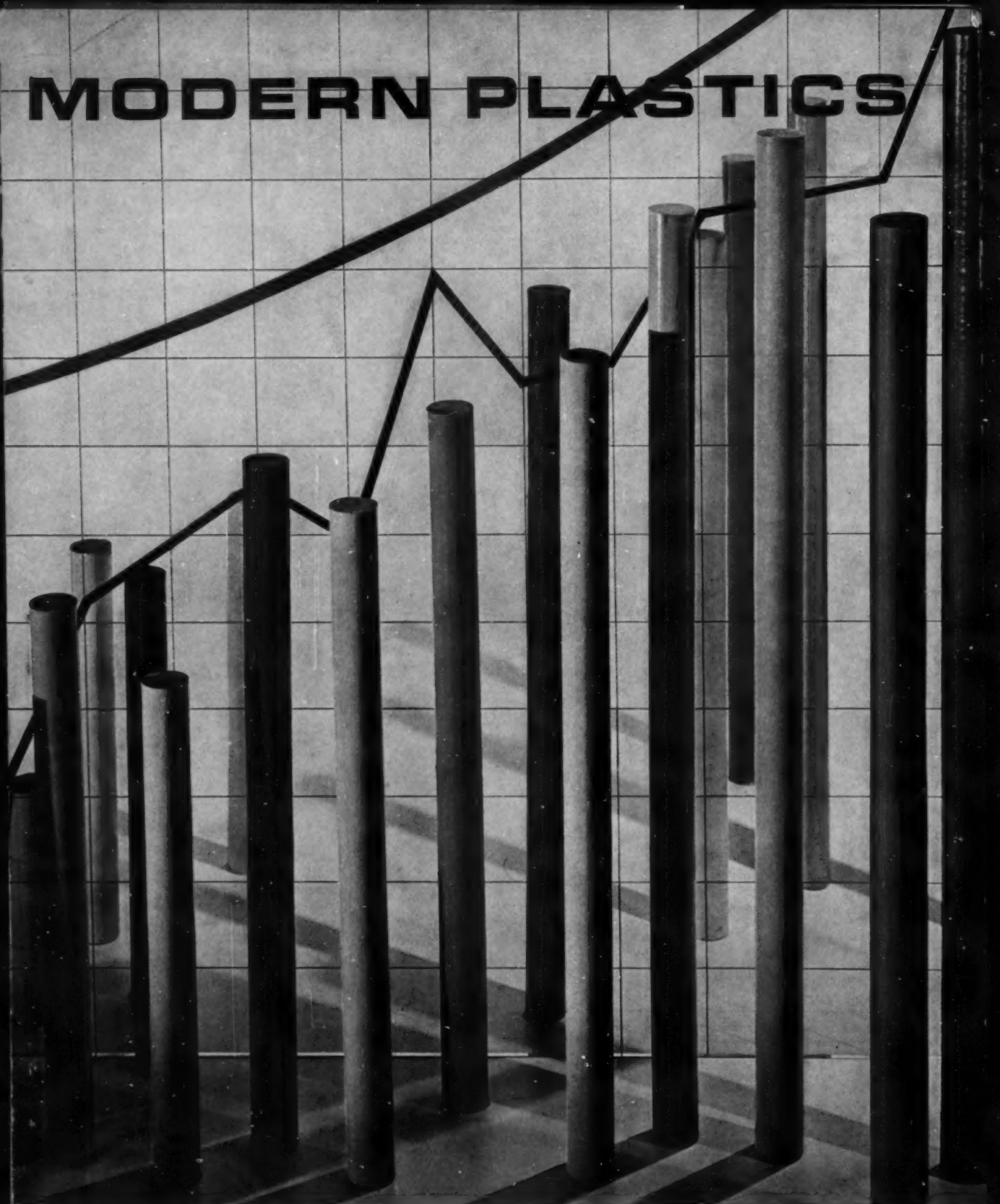
MODERN PLASTICS



DESIGNED FOR MODERN PLASTICS BY S. NEIL FUJITA

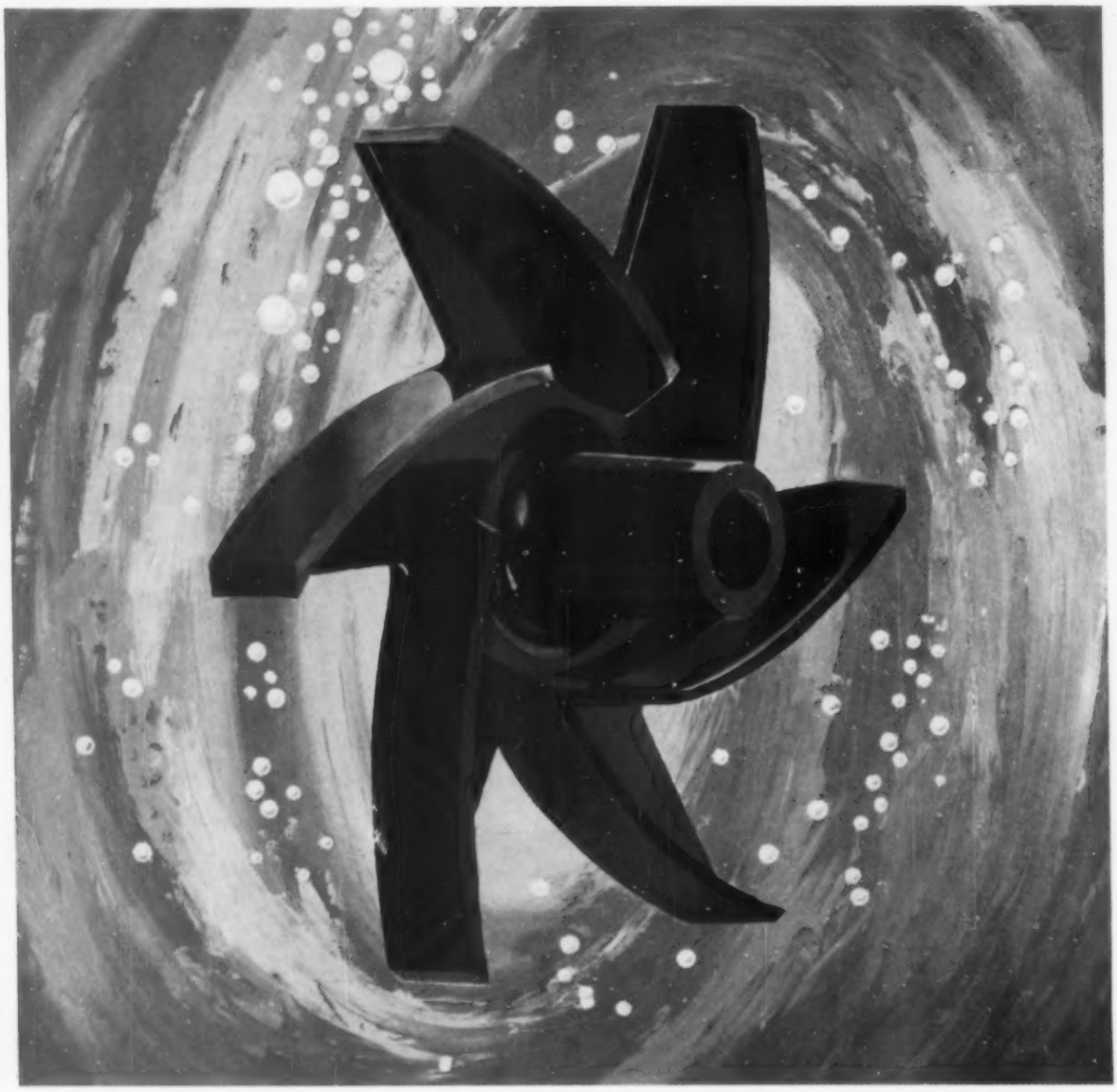
1960 IN REVIEW—TRENDS FOR THE YEARS AHEAD

Materials *p. 82* | **Machines** *p. 119* | **Engineering** *p. 123* | **Technology** *p. 141*

Applications highlights for 1960—and what they portend

JANUARY 1961

One of a series directed to IDEA-MEN



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MODERN PLASTICS

Volume 38, Number 5 January 1961

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Polyethylene **84**

High-density PE increased by over 80%; conventional resins maintained 1959 figure. Considerable film expansion is foreseen.

Polypropylene **91**

Capacity is expected to reach 300 million lb. in '61 with consumption at less than 100 million. Eight producers are expected to be in the picture by '62.

Vinyl chloride **91**

Good increases were recorded in film, sheeting, and coatings; but floor coverings grew only slightly. Capacity will soon be 1.4 billion lb., with current sales of around 800 million.

Polystyrene **97**

Packaging applications showed phenomenal strength, picked up some of the poundage lost through reduced refrigerator production. Copolymers have started to move ahead briskly.

Cellulosics **102**

Market for molding and extrusion materials has leveled off, but blow molding holds promise for an upsurge in sales.

Methacrylate **104**

Impact materials are continuing their steady growth; sirups are making progress in reinforced plastics. Otherwise market situation remained about same as for 1959.

Nylon **105**

A 20¢/lb. price reduction is expected to lead to broadened market base, but came too late in the year to affect 1960 sales, which were slightly below the 1959 performance.

Acetal **106**

After first full year of commercial production, the resin showed up in more than 400 applications.

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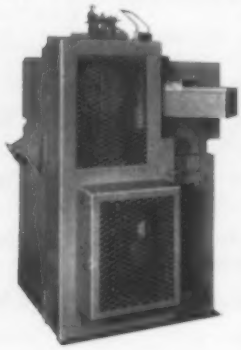

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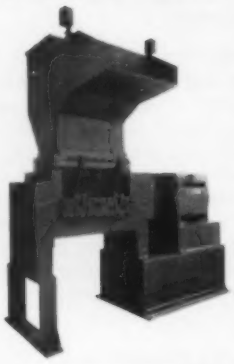

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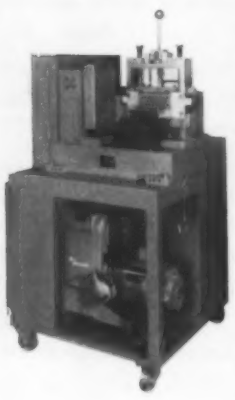

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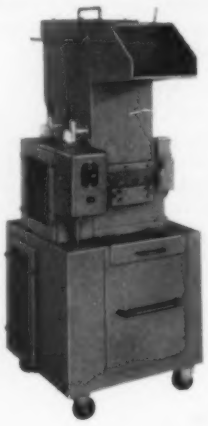

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Cumberland New Extra Large Granulating Machines.

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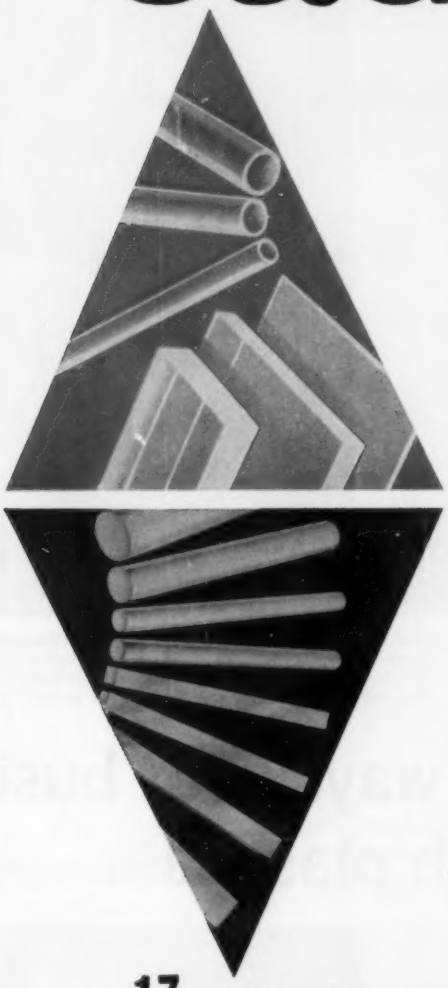

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Look at the ways your business can grow with plastics from B.F.Goodrich

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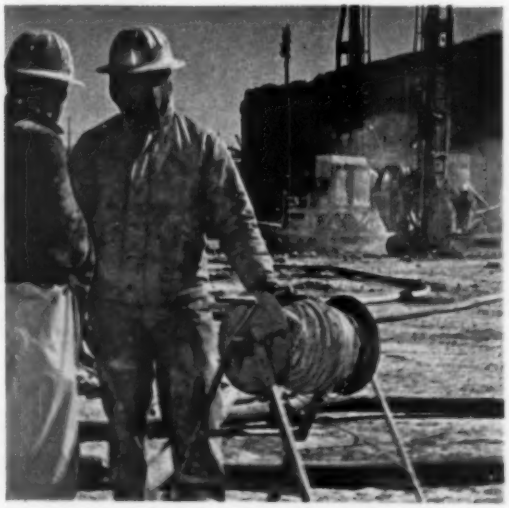

DELIVERS THE SHOCK WITHOUT DAMAGE— to itself. This detonating wire is insulated with Geon vinyl to provide outstanding electrical insulation and resistance to abrasion (it is often pulled over sharp rocks), weathering or aging. Geon also makes possible the bright identifying color.

copper pipe next to it, even though steaming hot water causes other types of plastic pipe (blue) to soften and droop. Test also shows the low heat transmission of hi-temp Geon. "Sweating" and heat loss are minimized. To illustrate, bar of soft metal on copper pipe is melting while identical bar on hi-temp Geon pipe remains solid. What test doesn't show: hi-temp Geon pipe is much lighter, less costly to install than metal pipe . . . and it can also be used to handle hot corrosive chemicals.

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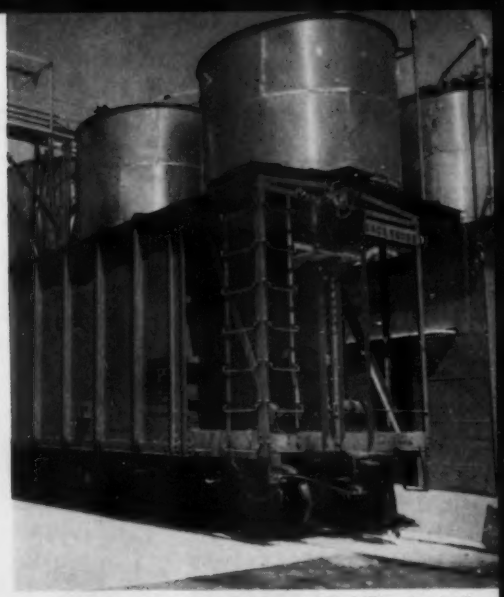
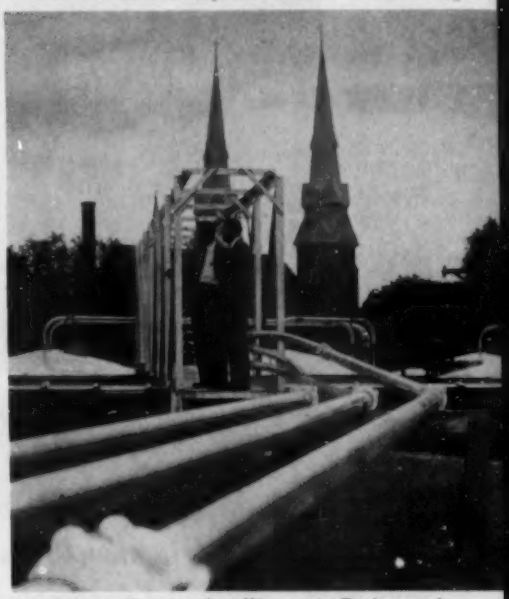


ABOVE: *Saves on resin cost.* Tuf-Flex in bulk costs 1¼ cents less a pound than in multiwall bags.



ABOVE: *Saves on handling costs.* Resin goes from cars to silos to molding machines—automatically.

BELOW: *Saves plant space.* Outdoor storage silos free valuable indoor areas.

tiny cyclones cased in plastic safeguard road monster's mighty engines

Molding New Ideas Into Plastic

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Ridges on lower cyclone tube snap air-tight on baffle plate.

Cluster of vane and tube sub-assemblies in air cleaner.

Switch from metal to molded plastic cuts cost...simplifies assembly...resists corrosion...prolongs life of Donaclone air cleaner.

Severe dust concentrations encountered by many huge earth moving vehicles could ruin engines in a single day without efficient air cleaning equipment.

To protect these engines, Donaldson Company, St. Paul, Minn., builds a dry type air cleaner. Plastic helix vanes and cyclone tubes in the cleaner produce violent whirlwinds that blast 98% of the dust particles from the air stream. Paper filter traps remaining dust.

Original vanes and tubes were designed in metal; however, finishing costs were too high. So Minnesota Plastics was asked to mold a two-piece helix vane to fit the cyclone tube. Minnesota Plastics met the challenge. Going beyond the specifications, a one-piece helix vane and air tight cyclone tube were designed and found not only to be more functional, but reduced costs.

Compared to original metallic models, costs of the new cyclone tube were slashed *in half* and helix vanes were cut about *one-third*.

This is another example of the *extra* services, beyond molding plastics, that you can expect from Minnesota Plastics. If you are looking for fresh ideas to improve your products with plastic, write or wire Minnesota Plastics *first*. It could very well save you time, money and effort.

m p c

PIONEER MANUFACTURER OF NEW PRODUCTS IN PLASTIC

Minnesota Plastics Corporation

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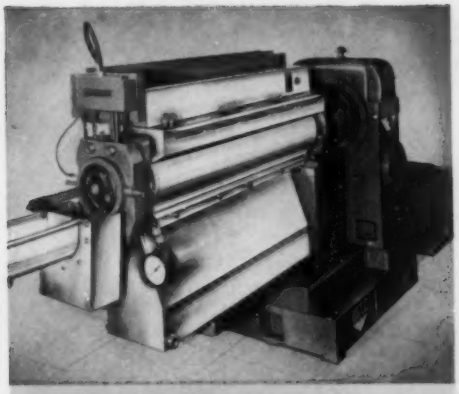

#3 (3½" bore) Royle Spirod Extruder showing section of retractable Cooling Tank.

for plastic pipe production specify ROYLE right down the line!

Royle Pipe Haul-Off units are designed for trouble-free handling of rigid and semi-rigid pipe, in a range of sizes from 2" to 6" O.D. Features include: pneumatically adjustable gripping force, cushion tensioning on traction belts, rugged steel weldment construction to match high pulling capacities and height adjustable stands. Speeds are synchronized with the Royle Extruder by a common control panel.

The new Royle Dual Coiler developed to coil flexible pipe or tubing. It features collapsible coiling heads, electric clutches for engaging heads, prewired operator's control station and constant torque drive.

If you produce plastic pipe — polyethylene, rigid or semi-rigid PVC, Kralastic, Cycolac, nylon, polypropylene or any other compound —choose Royle equipment.

Now you can get Royle quality — Royle dependability — Royle performance along your entire pipe production line — from hopper to finished plastic pipe. Every unit you need can carry the famous Royle triangle — Extruders, Cooling Tanks, Pipe Haul-Offs and Coilers; as well as all necessary auxiliary equipment, including Control Panels, Dies and Cutting equipment.

So, for customized Pipe and Profile Extrusion Systems — get engineered equipment — join the swing to Royle.

As they have been since 1880 — Royle is first in Extruder development.

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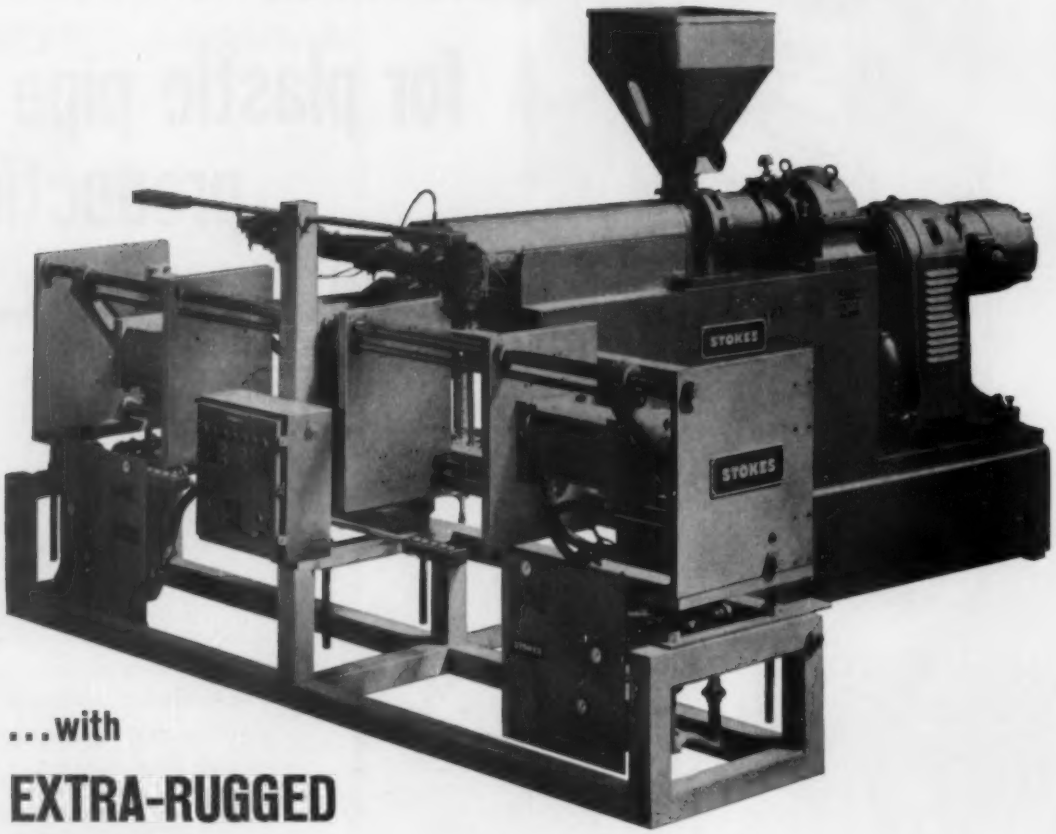
Pioneered the Continuous Extrusion Process in 1880

Home Office, V. M. Hovey, J. W. VanRiper, SHerwood 2-8262. **Akron, Ohio**, J. C. Clinefelter Co., BLackstone 3-9222. **Downey, Cal.**, H. M. Royal, Inc., TOpaz 1-0371. **London, England**, James Day (Machinery) Ltd., Hyde Park 2439-0456. **Tokyo, Japan**, Okura Trading Company, Ltd., (56) 2130-2149.

new STOKES high-capacity blow molder...



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Big news in blow molding! New Stokes Model 856 gives you the proved operating flexibility of dual-manifold design . . . *plus* dramatically increased capacity.

You get 550 square inches of mold area on each platen . . . 13-inch stroke . . . 5 tons of clamp . . . 28 inches of daylight with molds open. You can use a 2½-inch or a larger 3½-inch extruder . . . choose pneumatic or hydraulic action . . . operate one or both mold stations manually, semi-automatically or automatically with continuous or intermittent extrusion.

New platen guiding technique gives you precise mold alignment . . . new single-cylinder drive assures uniform closing rate for both molds . . . new photocell control provides greater safety. These are just a few of the features that enable the new Stokes Molder to pay off in more profitable production for you!

Packaging Equipment Division

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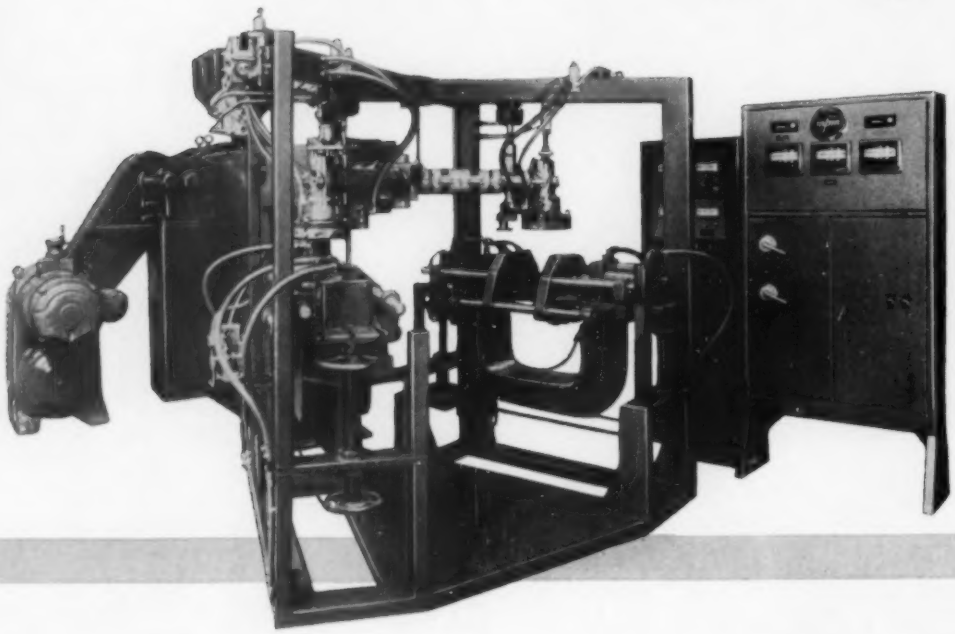


MPM's new "Diversamatic" twin-station is the fastest, most versatile unit available.

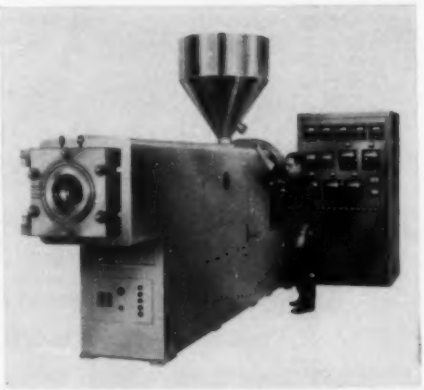
You owe it to yourself to check the advanced design features of MPM's new "Diversamatic" blow-molding machine.

Unique twin-station design lets you operate two identical or different molds at the same time. Once the machine is set up (easily done with manual controls), you switch over to automatic for high-speed, continuous operation.

You can produce single or vertically strung multiple-cavity work in lengths of up to nearly three feet! Materials blown include low- and high-density polyethylene, polypropylene, high-impact styrene, nylon and other materials.

The "Diversamatic" can be used with *any* extruder, domestic or foreign. If you wish, MPM will provide the *complete* unit, including extruder (see photo at right). Moreover, MPM will operate the unit for your inspection *prior* to shipment, then help you put it into operation in your plant.

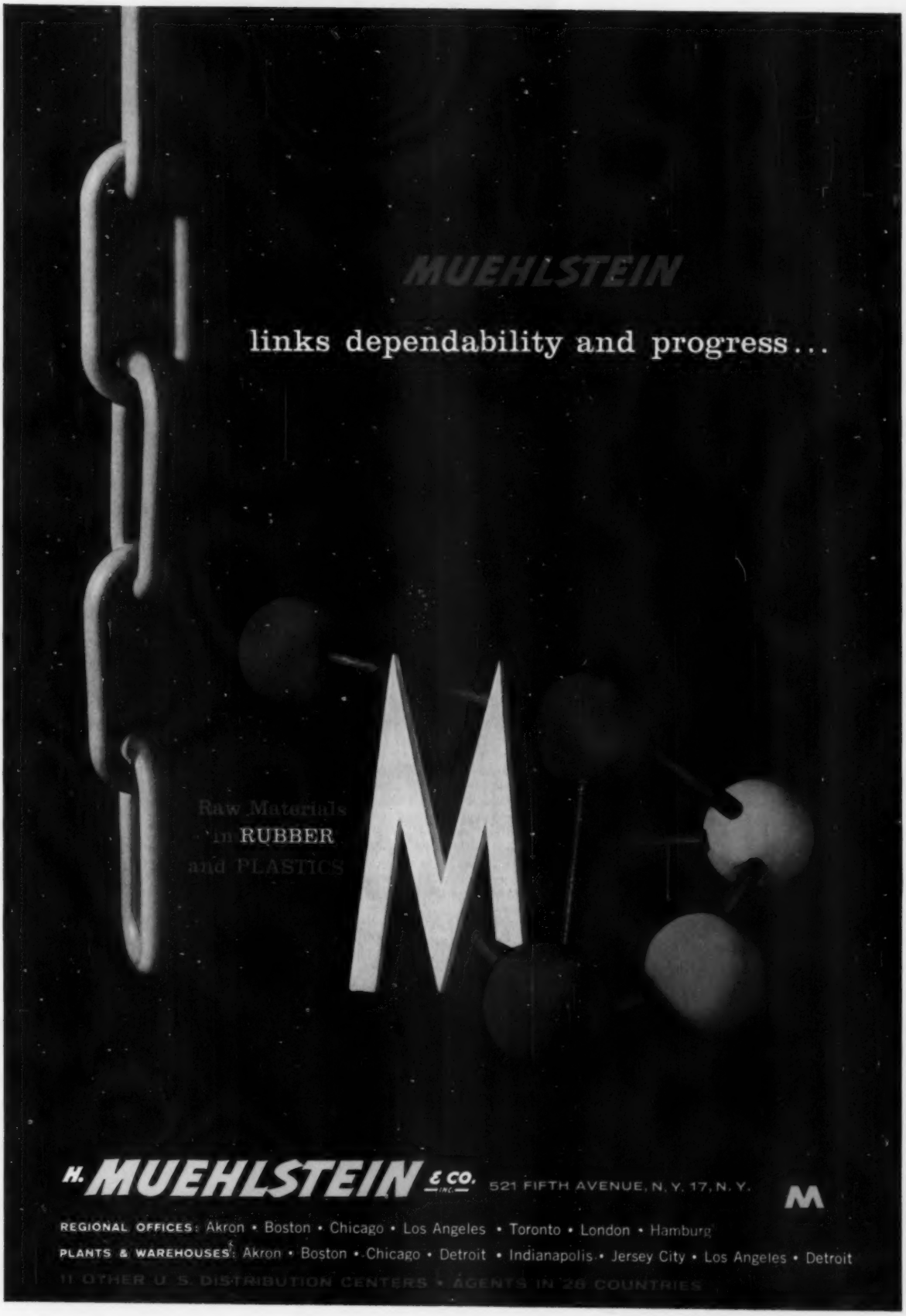
In addition to the "Diversamatic," MPM manufactures a one-station, two-head machine, two-station machines with either four or eight heads, and a new six-station *rotary* machine. For information on any or all of these, just drop us a note.



MPM COMPLETE PACKAGE UNIT includes an MPM extruder, "Diversamatic" twin-station blow-molding equipment, and the tooling, if desired.

Modern Plastic Machinery Corporation

General offices and engineering laboratories: 64 Lakeview Avenue, Clifton, N. J.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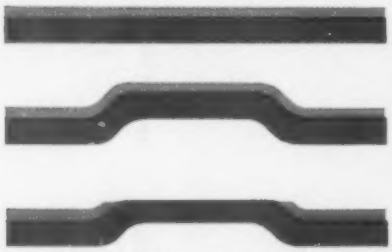
Here's news about Butyrate plastic...

Duplex Butyrate sheet yields 2-color signs that by-pass usual decorating...the sheet itself provides the second color

Duplex sheet is formed in the same manner as regular Butyrate sheet for signs.



Duplex Butyrate sheet consists of a single thickness with thick and thin layers of Butyrate in two different colors.

After forming, the thin layer of color is sanded away from certain raised areas to expose the second color underneath.

The versatility of Tenite Butyrate as a plastic material for signs gains added recognition with the development of duplex sheet. By taking advantage of the ingenious construction of this new sheet, the creative sign designer and sign builder can produce 2-color effects without use of lacquers or inks.

In essence, duplex Butyrate plastic sheet consists of a heavy layer of one color under a thin layer of a second color. The sheet is produced by extruding and laminating one layer of colored plastic directly upon another layer of a different contrasting color. For example, a duplex sheet for forming a representative 4- by 8-foot sign panel might have a heavy layer 0.090-inch thick and a thin layer 0.010-inch thick.

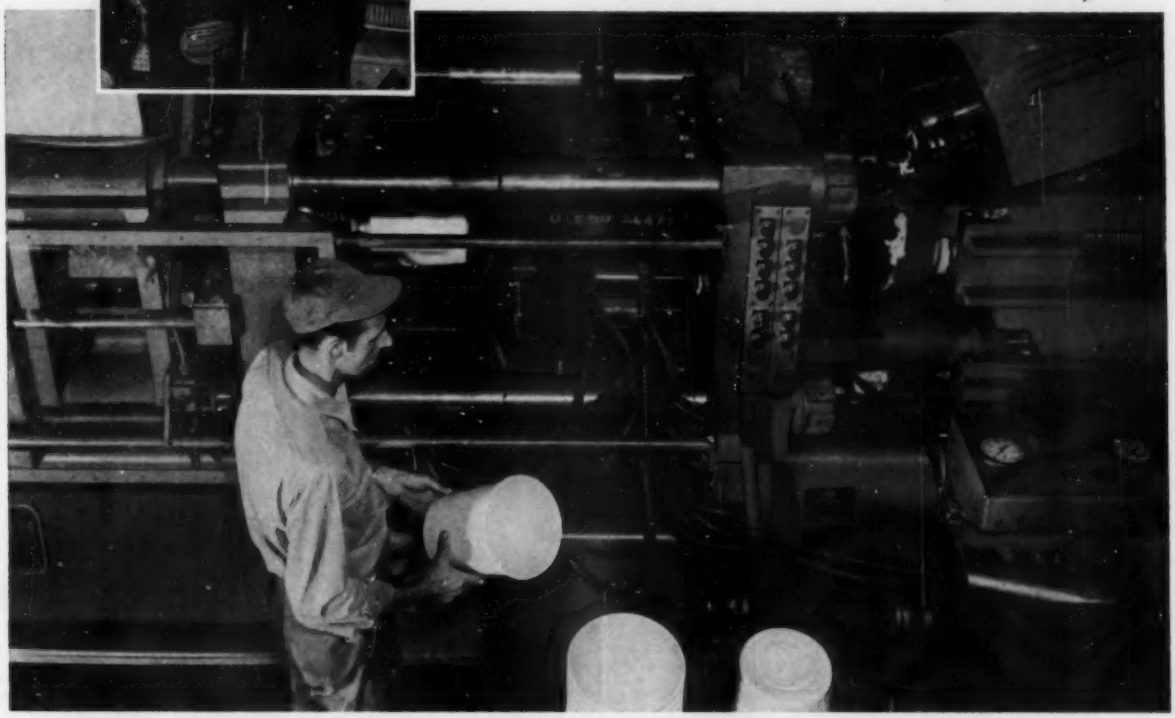
After the sheet has been formed into a sign panel or element, with the thin layer on the appearance side, the color of the heavy layer may be quickly exposed by sanding away the thin layer from the raised surfaces of the sign face. The choice of color combinations will be determined by the effects desired, the specific application, the use (or the non-use) of backlighting, and the esthetic preference of the individual sign designer.

For information on availability of duplex Butyrate sheet, write to the Plastics Division, EASTMAN CHEMICAL PRODUCTS, INC., KINGSPORT, TENNESSEE, or to the sales office nearest you.

TENITE®
BUTYRATE
an Eastman plastic

G. W. KENY, President
Columbus Plastics Products, Inc.
Columbus, Ohio

"Our selection of injection molding machines allows little margin for error. As both manufacturer and distributor for Lustro-Ware plastic houseware items we make sure that the machines we buy have the rugged qualities to withstand our 24-hour production schedule. We have standardized on H-P-Ms for the past several years and now have 26 of them. They have proved most satisfactory through the years."



125 MILLION PLASTIC PARTS PER YEAR

Progress in Plastics by
A MOLDER ON THE MOVE

The new 28 oz. preplasticizer, illustrated, is just one of many new H-P-Ms that Columbus Plastics rely on to meet its tremendous molding schedule. In some cases, production has been increased by 40% with these new units. Last year this company molded in excess of 125 million plastic houseware parts. Only injection machines that can "take it" fit this kind of production.

If you're "moving" in the new market for plastics, why not insure your production potential with dependable H-P-M machines? Call H-P-M, today.

HPM

H-P-M DIVISION
Koehring Company
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H102

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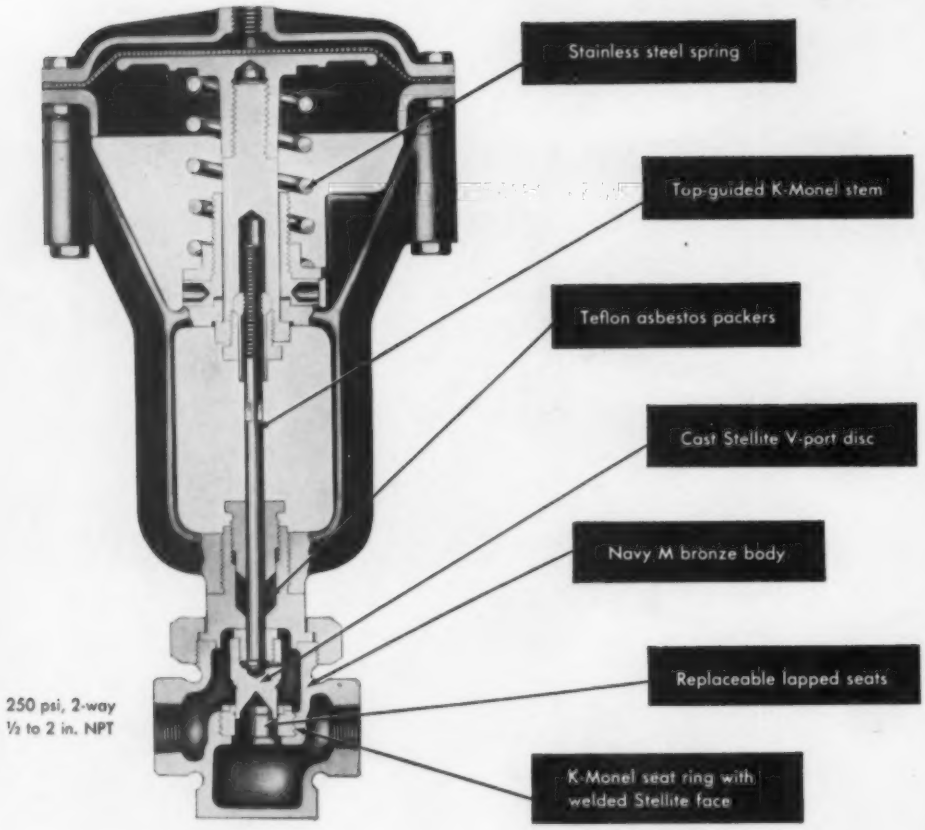

. . . for precise control of pressure or temperature . . . steam, hot or cold <u>raw</u> water service

Sinclair-Collins' V-port valves offer a solution to your temperature or pressure modulation problems. Designed for instrument actuation, they offer variable metering to provide extremely accurate and consistent control of media flow rates. Highest quality materials and Sinclair-Collins' precision manufacturing methods assure long, reliable service life, with minimum maintenance downtime. Stainless steel trim resists corrosion . . . Stellited seat ring and port disc resists wire drawing and cutting. Find out how S-C V-port valves can meet your control needs . . . a call to your near-by Sinclair-Collins Field engineer will bring prompt application engineering recommendations.

For more information write for free Bulletin SC-59. Address: Sinclair-Collins Valve Company, Akron 9, Ohio, Dept. MP-161

The SINCLAIR-COLLINS VALVE Co.

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Sharp and clear. Exposure-perfect. A ten-second miracle of picture-taking and picture-making automaticity that begins the instant the shutter snaps. PLENCO'S contribution is in the *picture roll holder* used in this astonishing Polaroid Electric Eye Camera Model 900, as well as in other cameras produced by Polaroid Corporation, Cambridge, Mass. The holder is made with Plenco 466 Phenolic Molding Compound, and the application here is rather an exacting one in that very close dimensional tolerances and freedom from warpage are required. We're pleased that Plenco continues to measure up to industry's highest engineering standards. We're confident that Plenco molding compounds, ready-made or custom-formulated, can measure up to yours.

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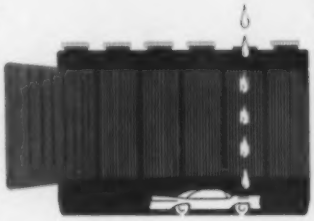

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SUPER DYLAN is strong, lightweight, non-corrosive, and chemically inert. It has low permeability, and good heat and dimensional stability. SUPER DYLAN also has a smooth, glossy finish . . . it makes a better-looking package and *it keeps costs down.*

SUPER DYLAN can also give your product a better package at lower cost. Write for more information on SUPER DYLAN and its applications. Koppers Company, Inc., Plastics Division, Dept. 1103, Pittsburgh 19, Pennsylvania. Koppers also makes these other fine plastics for packaging: DYLENE® polystyrene, DYLAN® polyethylene and DYLITE® expandable polystyrene.

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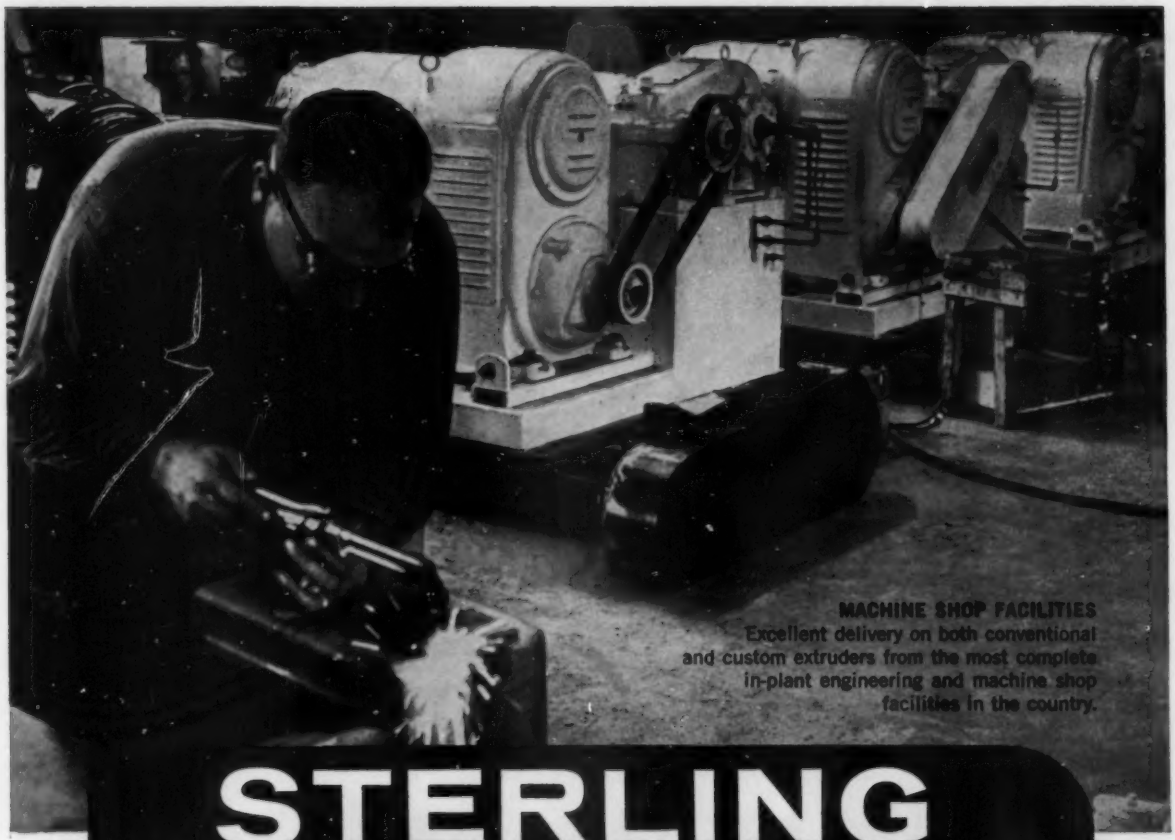

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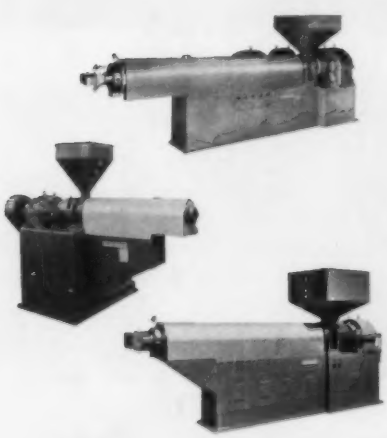

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If you have a problem involving polyolefin colors or special formulations . . . a Westchester recommendation of experience may provide the right answer. Write now for complete information.

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Erie Foundry regularly builds hydraulic molding presses in capacities of 25 to 4,000 tons. Our advanced design control systems will apply forces accurately and precisely, maintain platen temperatures within close tolerances, and perform molding cycles with split-second timing. Versatility is built in so that a wide range of molding jobs can be handled.

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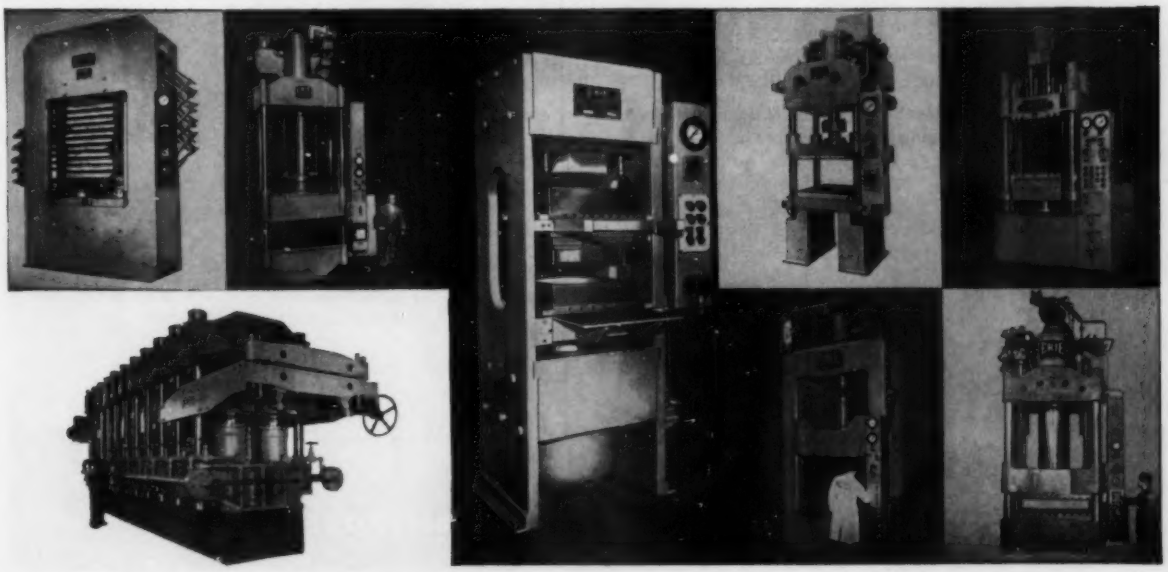
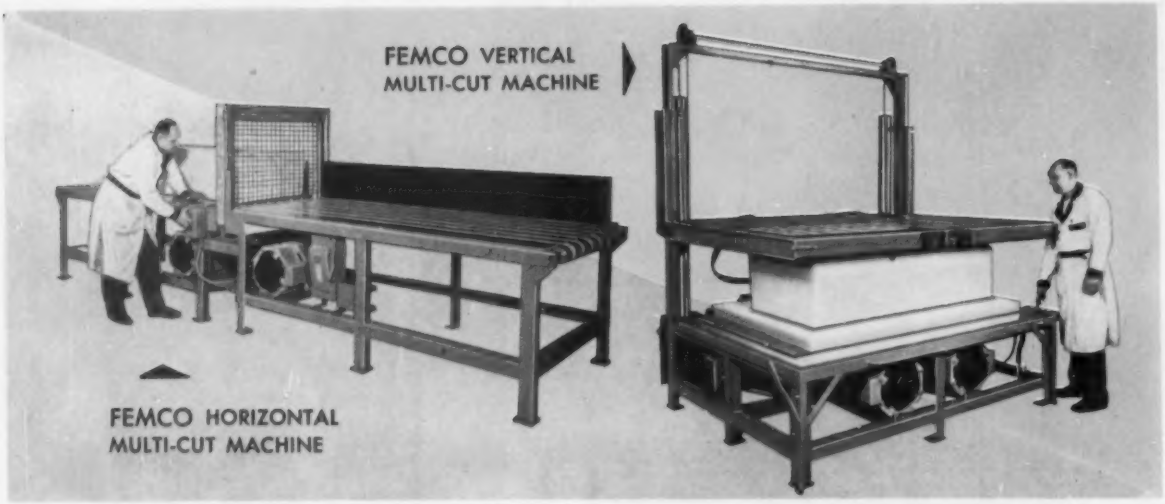




FEMCO'S New Multi-Cut Machines Can Reduce Foam Fabricating Costs As Much As 50%!

GREATLY REDUCE SCRAP LOSS!

Producing more, doing it faster, and at less cost is the big job facing distributors and fabricators of synthetic foams. Today, fabricators and distributors must sell approximately 2½ times as much synthetic foam as they formerly did foam rubber to maintain the same dollar volume of business.

To do this requires equipment that will perform as many cutting and fabricating steps in one operation as possible. FEMCO's new Vertical and Horizontal Multi-Cut Machines do just that.

In developing its Vertical and Horizontal Multi-Cut Machines, FEMCO has provided distributors and fabricators with two unique and relatively inexpensive pieces of equipment that will cut slabs of flexible or rigid foams into sheets or blocks of predetermined length, width and thickness in a minimum of time and with a minimum of handling.

One distributor now using a FEMCO Vertical Multi-Cut Machine reports an actual 50% reduction in fabricating costs. You probably can save that much, too!

On the Multi-Cut Machines, cutting is done by hot wire. The vertical Machine makes 18 vertical cuts in two directions simultaneously and will handle slabs of foam up to 77" x 108" x 48" thick. The Horizontal Unit will make 18 horizontal cuts in two directions simultaneously and can handle stock 69" x 36" and up to 20 feet in length if idler conveyors are added.

Both machines are extremely accurate since stock being cut is not under compression. They are preset and require no adjustments between cuts, eliminating any chance of operator error. Cutting wires on the Horizontal and Vertical Machines can be set at angles for cutting bolsters.

Below are the results of a time study run on the Vertical Multi-Cut Machine. Compare it with your present production figures and see at once how effective the Multi-Cut Machine is in increasing production and lowering costs.

TIME STUDY REPORT

FEMCO HW 7450 Multi-Cut Machine (48" vertical travel)

PRODUCT: Urethane foam furniture cushion.

PRODUCT SIZE: Original Slabs 45" x 67" x 4" thick (Pre-Split)

SIZE CUT: 22" x 21" x 4" thick.

BREAKDOWN OF OPERATION—(one operator)

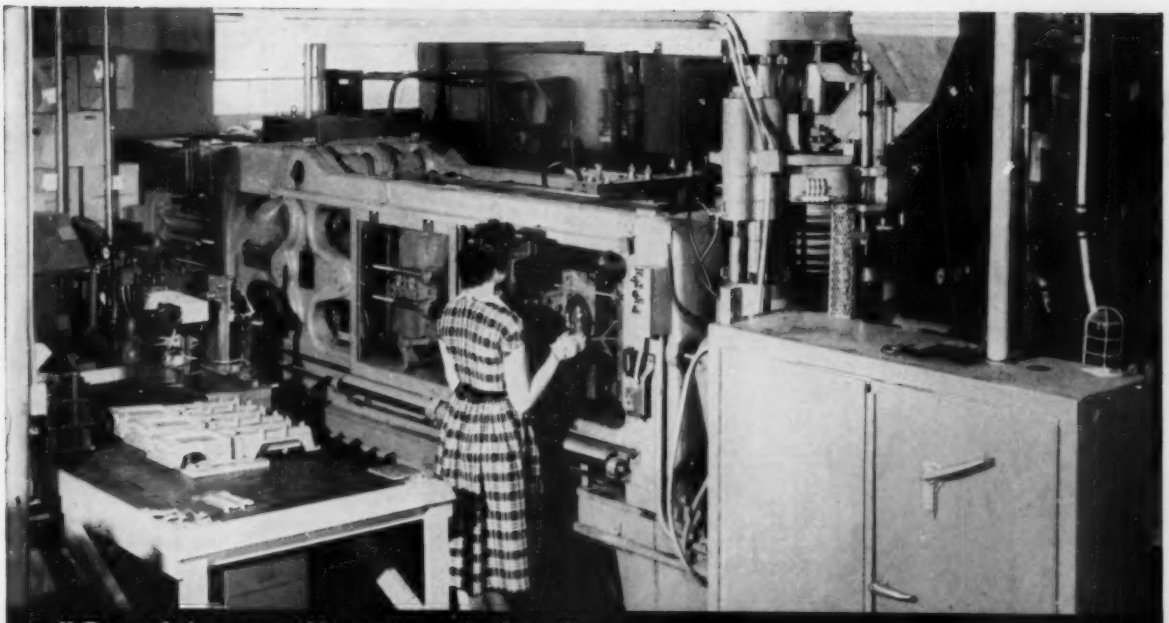
*1—Place 12 four-inch slabs on loading table	120 seconds
2—Move table into cutting position	3 seconds
3—Cutting time	150 seconds
4—Remove cut cushions	60 seconds
5—Move table back to load position	4 seconds
	337 seconds

72 cushions cut in 337 seconds = 4.7 seconds per cushion or 763 cushions per hour or 6,120 cushions per 8-hour day.

These production figures are subject to your efficiency standards.

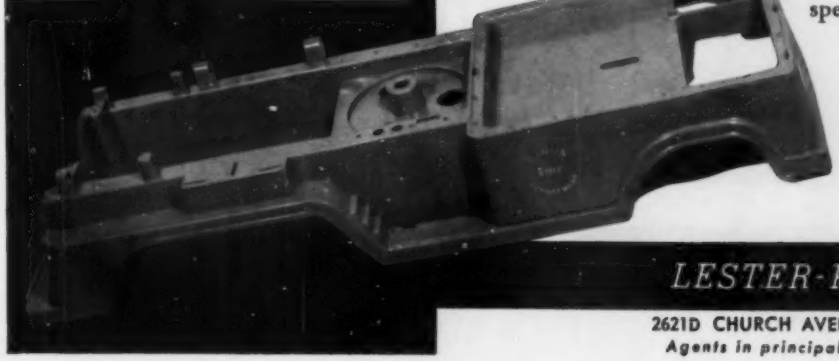
*Material could be pre-stacked accurately at splitter operation thereby reducing this handling time considerably.

FEMCO
The FALLS ENGINEERING AND MACHINE CO.
CUYAHOGA FALLS, O.
1917 44th YEAR OF BUSINESS 1961



"On this quality truck body

The 24/32 Oz. LESTER gives us 33% more production than we expected!"



"The new long-stroke 24/32-ounce Lester in our shop is molding this toy truck body 33% faster than the mold was planned for," says R. E. Roper of Delkay Plastics Corp. in Gardena, Calif.

It's a big part, weighing 22½ ounces of linear polyethylene—including the sprue and runners—in a 3-plate mold. The projected area is 216 sq. ins. with wall sections ranging from .062" to .125"... a tough job to fill and run steadily. Yet the Lester L-450-24/32 ounce machine takes it in stride and makes it a profitable job.

As an added bonus, the patented Lester Mold Overload Compensator (two pressure molding system) reduced the weight of the part by more than ½ ounce, and reduced strain at the same time—important to the durability of this "sit-on" toy.

The 24/32 ounce Lester, with its adjustable mold stroke of 8" to 30" and certified clamp of 450 tons can handle those big jobs for you, too. Write for detailed specifications.

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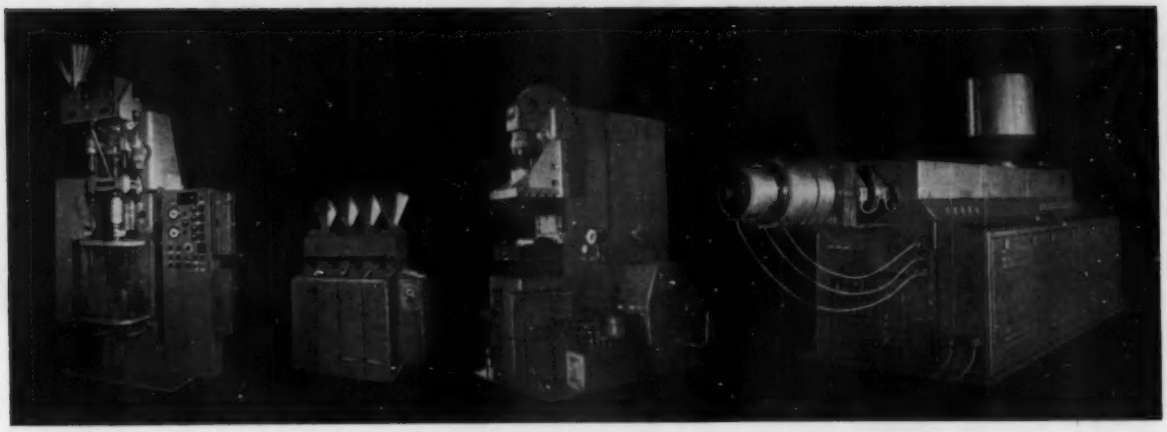

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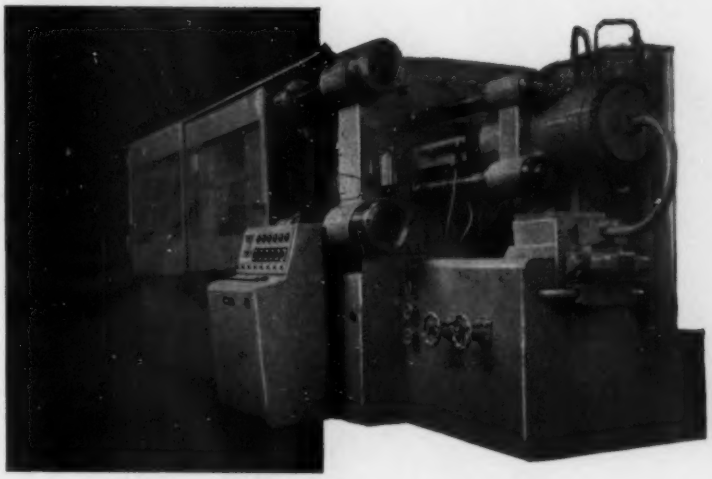

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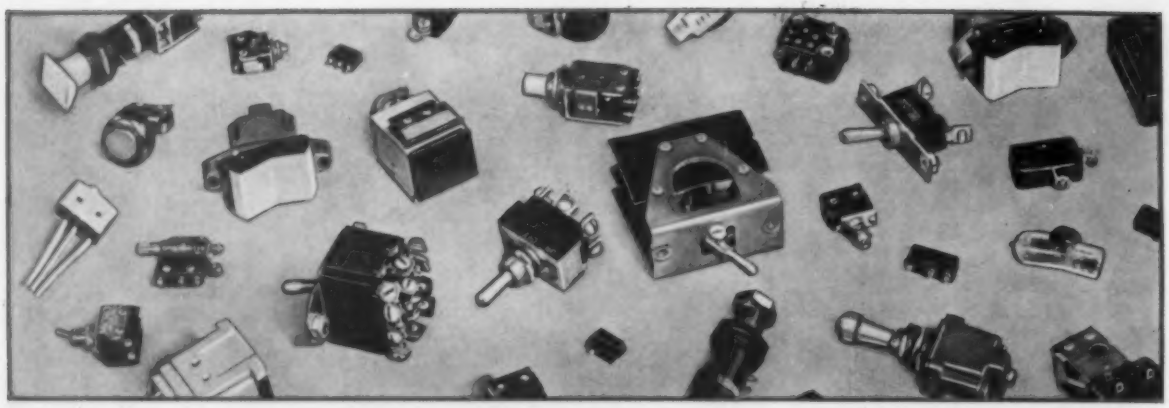
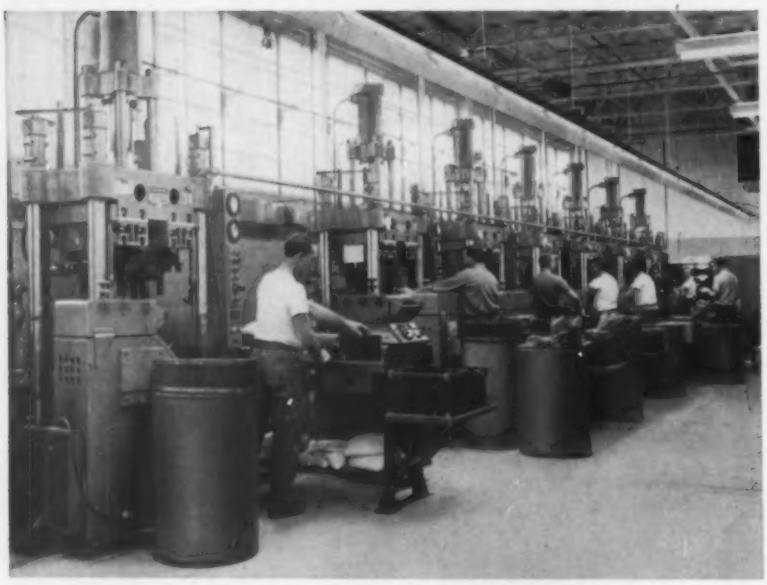
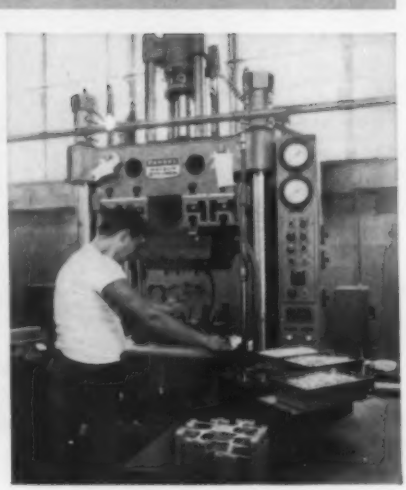


24 Farrel Watson-Stillman transfer machines mold intricate Micro Switch cases to close tolerances



ABOVE: Seven of the 18 Farrel Watson-Stillman 200-ton transfer molding machines at Micro Switch. Capacities of the other 6 machines range from 50 to 150 tons.

RIGHT: Operator removing 8 plastic switch cases from the mold of a 200-ton machine. The horizontal platen eliminates the need for elaborate holding devices . . . reduces possibility of mold damage.



The switches you see above are but a small sampling of the 12,000 types made by Micro Switch . . . pioneers in the miniaturization of switches. Pioneers, too, in the field of precision.

Thus, when it comes to molding plastic cases, Micro Switch needs precise equipment, which is why they have installed 24 Farrel Watson-Stillman transfer machines. These machines provide the molding control necessary for the placing of delicate inserts. What's more, they hold dimensional tolerances to plus or minus .003", or better — vitally important when switch components must be interchangeable.

For your own molding operation, it will pay you to investigate the advantages of Farrel Watson-Stillman transfer molding machines. Send for new bulletin 640-D.

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WS-78

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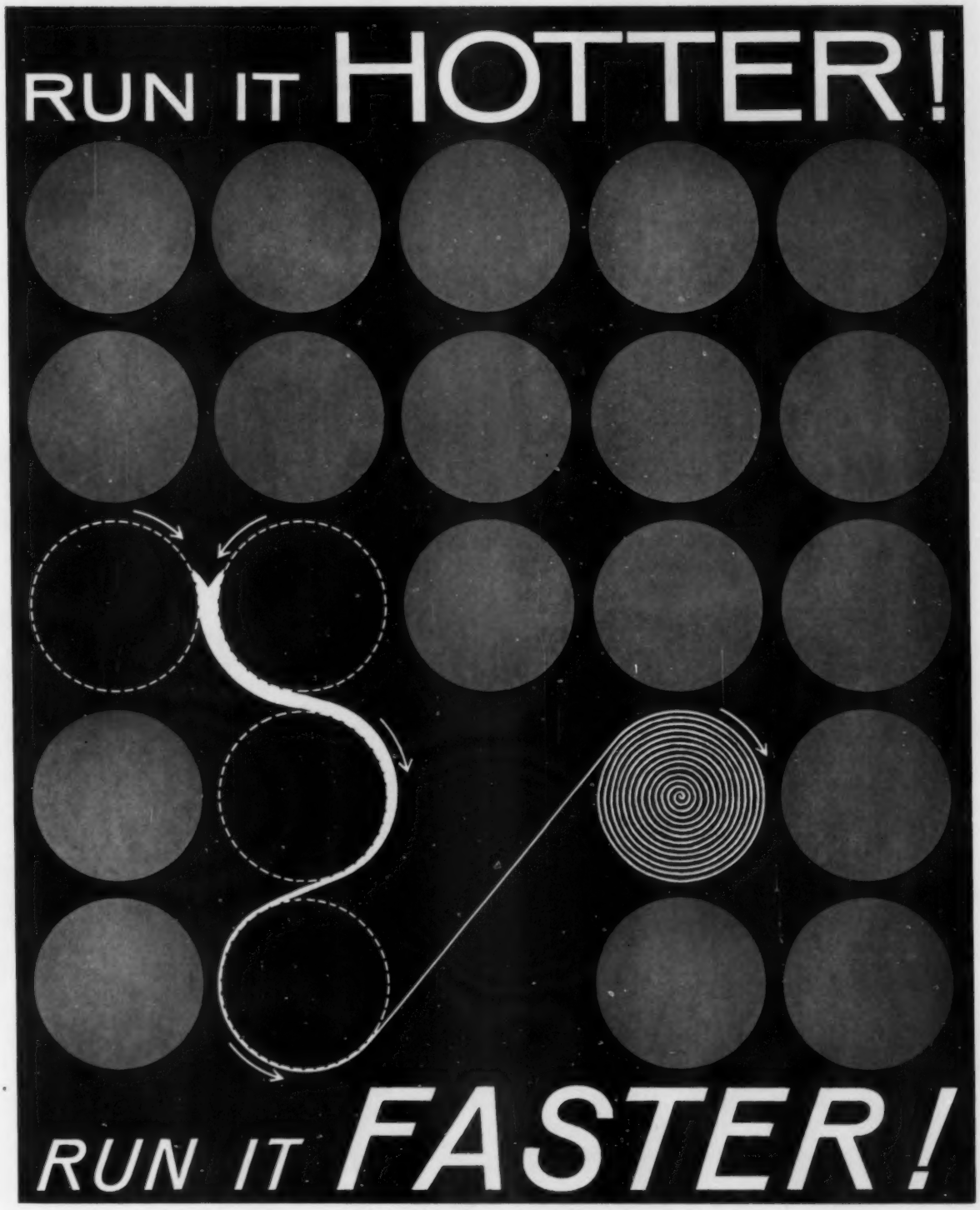

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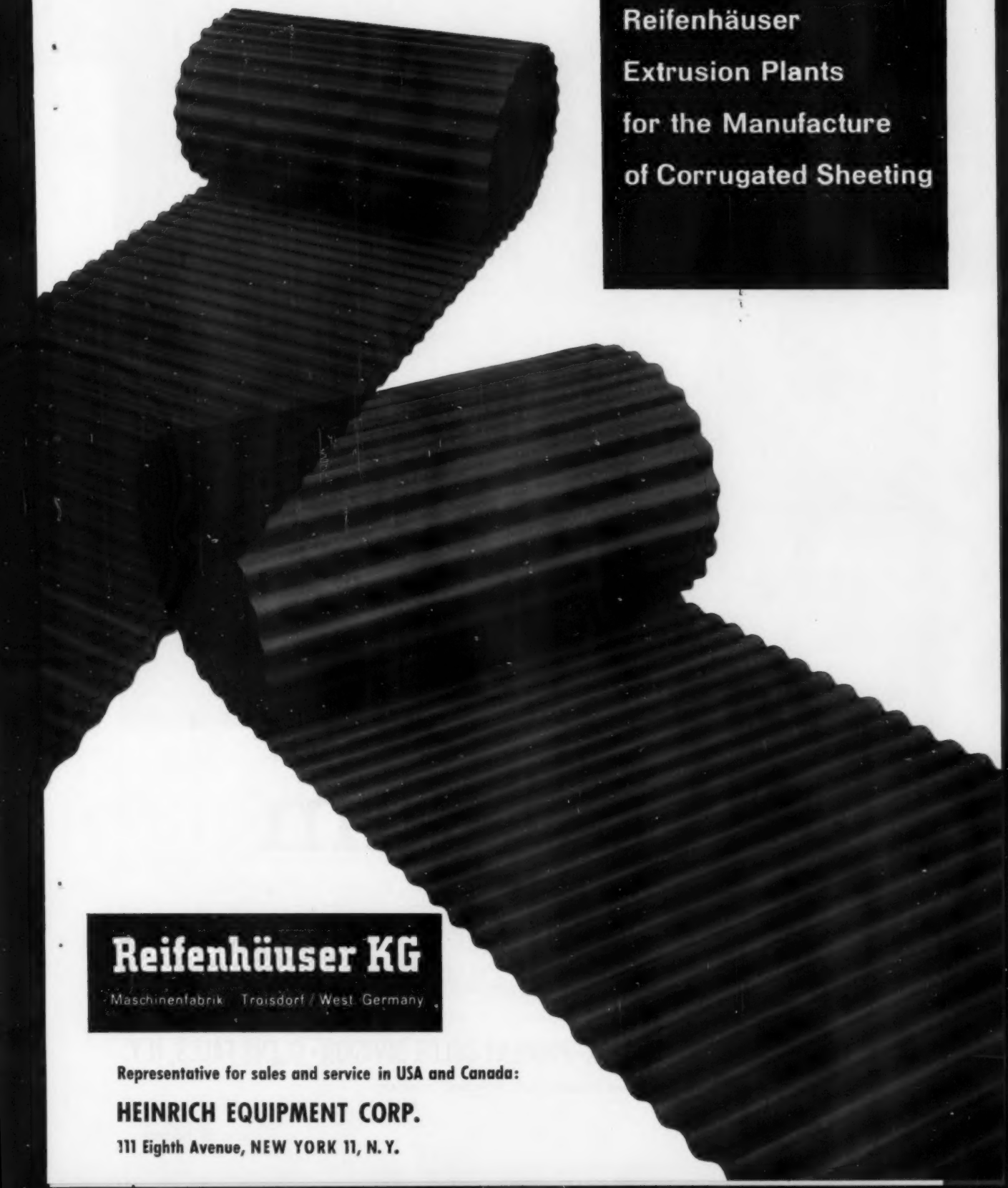

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THE PLASTISCOPE*

News and interpretations of the news — By R. L. Van Boskirk

Section 1 — January 1961

Teslar growing up

Du Pont's vinyl fluoride film is now apparently undergoing vigorous testing at several installations with most satisfactory results. It is passing muster on two houses where it is used in the form of a 1½-mil pigmented film over a 10-mil aluminum strip for siding. As a lamination of 2-mil film and aluminized steel strip, it has been post-formed into siding and roofing panels for use on a 200,000-sq.-ft. installation at Du Pont's plant at Florence, S. C. At another test house, white pigmented Teslar film on hard board is undergoing trial. It could probably be put on a house at a cost of no more than $100 above that of paint but promises three or four times longer service. A corrugated galvanized siding faced with a pigmented Teslar is incorporated as an exterior wall at a recently constructed Du Pont research laboratory installation.

There are other building application areas. As a white 4-mil roofing material, the film reflects heat—can be laminated to a fibrous asphalt-filled mat to form a sturdy covering that can be walked on. It can also be applied to a metal strip by the Marvibond process. This Teslar-metal laminate can be post-formed without danger of rupturing the film.

Another possibility for the film is a surfacing material on either one or both sides of reinforced plastics paneling; here the film doubles as a mold-release agent during the manufacturing process. A clear Teslar is also being evaluated for solar stills, since it passes 95% of the sun's radiant energy.

Du Pont's faith in the future of Teslar has been evidenced by an announcement that construction of a new plant to make commercial quantities will begin early in 1961. It is expected to start operations in mid-1962. At present only a semi-works plant is producing the film.

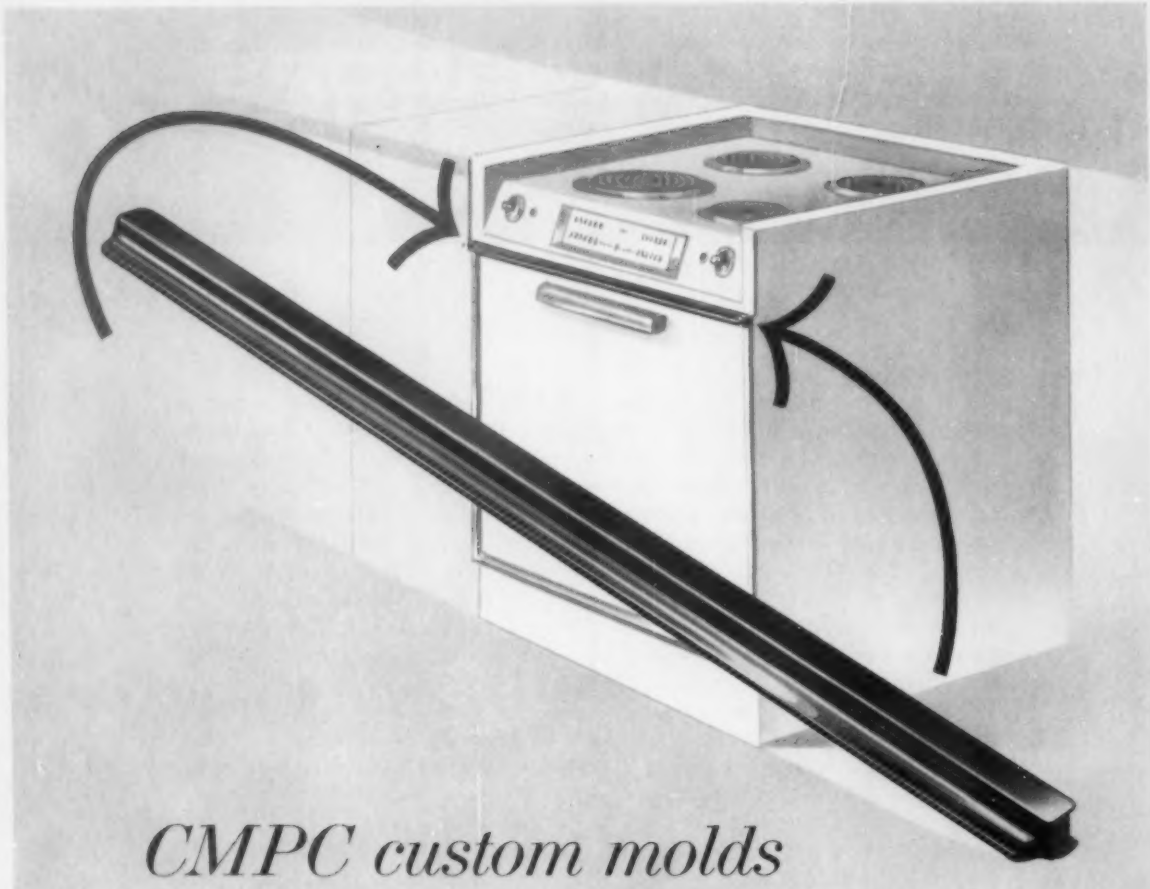
New entrant in methacrylate field

Escambia Chemical Corp., expected to make an entrance into the methacrylate industry for several years, has now completed the last stages of its development program and will start construction of a commercial-size plant in 1961. Completion is expected sometime in 1962. The plant site, still to be selected, will be at one of the following: Pensacola, Fla., elsewhere on Gulf Coast, or between New York and Chicago.

The Escambia product will be made direct from isobutylene, nitric acid, and alcohols through an intermediate to methacrylic acid and its esters. The company says these are lower-cost raw materials than the presently used hydrogen cyanide and acetone, present no by-product disposal problem, and thus could make possible a lower-cost methacrylic acid.

Test results indicate that the new methacrylate will compete favorably with present molding and casting resins, according to company officials; but Escambia seems to be particularly interested in producing for surface coatings—such as a baked-on material that gives the hardness, flexing, adhesion, and luster expected from acrylics—and the exterior paint market, in which acrylic formulations are being applied in growing quantities. **(More on page 41)**

*Reg. U.S. Pat. Off.



CMPC custom molds phenolic heat deflector for General Electric ranges

Certain models of General Electric's new line of Mark 27 built-in ranges are sporting an attractive CMPC-molded phenolic heat deflector. The 26-inch compression molded deflector, with a top continuous use temperature of 400 degrees F, is used to divert oven heat from the range control panel. By isolating controls from the effects of heat, the CMPC part helps insure longer, trouble-free service—something for which General Electric is famous.

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THE PLASTISCOPE

Monsanto's new styrene copolymers

The new styrene-acrylonitrile copolymers (Lustran A) and terpolymers of styrene, acrylonitrile, and butadiene (Lustran I) to be produced in the new 50-million-lb. plant at Addyston, Ohio, are to be considerably different from the styrene-type copolymers now on the market, according to statements made by Monsanto Chemical Co. officials.

The new materials are produced by a Monsanto-developed graft polymerization technique that permits meeting a wide range of desired specifications. They are made from the same raw materials as the other styrene copolymers, but the polymerization technique employed will give a more rigid and glossier material with greater strength, toughness, and abrasion resistance, according to Monsanto. Small quantities of this material have been used in Japan for the past year for such television parts as lenses and masks.

The price range will be from 37 to 51¢ per pound. Paul Stahlberg, manager of styrene plastics sales, says these new Lustrans may account for as much as 40 to 50% of total styrene molding in the 1960's and will be used in appliances, autos, luggage, telephones, shoe heels, television, toys, and packages which will capitalize on the material's toughness and chemical resistance.

Cementable Teflon

Du Pont's FEP film is now available in a new form treated on one side so that it can be cemented to other materials with common adhesives. It shares all the properties of the older TFE-fluorocarbon films at temperatures up to 400° F. Its outdoor life is virtually unlimited and it is clearer than the older TFE film, according to Du Pont.

The new cementable type is compatible with epoxy, rubber, or any other adhesives, in contrast to the standard Teflon FEP, which is almost impossible to cement without special surface treatment. The new film can be bonded to cloth or other substrata. It has been bonded to polyethylene prior to vacuum forming. It has also been adhered to glass-reinforced polyester panels as a means of imparting flame retardance.

The FEP resin from which the film is made is fluorinated ethylene-propylene—a copolymer of TFE and hexafluoropropylene. According to Du Pont, it is easier to process, can be extruded into film which is void-free, and can be heat-sealed or bonded. Films of the older TFE had to be cast, skived, or solvent-extruded and sintered.

Increased capacity for vinyl chloride

Mr. Irwin Cohn, president of Great American Plastics Co., vigorously denies rumors that his company is to be sold or merged. On the contrary, its capacity for producing vinyl chloride resins and compounds is being increased. His company's compounding business has increased 300% since 1959, according to Mr. Cohn, and now has nine different vinyl chloride formulations that cover nearly all vinyl applications, including wire and cable covering, floor covering, calendering, rigids, etc.

The company has also established a large blow-molding operation. Among products blown are large toy racing cars, 90-gal. square containers, and 70-gal. round containers.

(More on page 43)

Davidson Rubber Company began business in 1857 making flexible products for the drug and surgical industries. They subsequently branched out into the shoe and automotive fields. Today they are concentrating one hundred percent on urethane foam products . . . have already established wide acceptance for their high quality molded products in the automotive and furniture industries. Here Davidson's technical director tells why Wyandotte is one of their important suppliers of chemical raw materials.

Bruce G. Hood lays it on the line

"We depend on Wyandotte for all the polyether materials used in our urethane foams," says Bruce G. Hood, technical director, Davidson Rubber Company, Dover, New Hampshire. "The reason: Wyandotte's fine technical service, technological leadership, and proven ability to cooperate with us.

"Ours is a progressive company, geared to supply flexible products to fulfill the promise of a dynamic future for many industries. How much we succeed depends a great deal on the resourcefulness of our suppliers like Wyandotte . . . for the availability of new and advanced materials is the cornerstone of our progress."

Naturally, Wyandotte is proud to be a part of the Davidson success story.

We believe that urethane foams have an almost limitless future. That's why we're one of the few chemical raw-material suppliers with research teams devoting full time to urethane chemistry.

In every major industry, from urethane foams and plastics to paper, rubber, and petroleum, Key Chemicals from Wyandotte are broadening horizons. May we serve you? *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Offices in principal cities.*

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THE PLASTISCOPE

Foreign price for polyethylene

When I.C.I. reduced the price of its high-pressure-processed polyethylene in the United Kingdom last month, it was the fourth reduction since September 1958. The new price is now the equivalent of 25.6¢/lb., compared with 27.5¢/lb. for the American produced resin. A well-informed source says that one of the reasons for the British price reduction was competition from imported American resin. The I.C.I. price reduction was met immediately in the United Kingdom by the American producers—Union Carbide and Monsanto Chemical—who have plants in that area.

With the excess capacity now available in the U. S., there is little chance that I.C.I. resin will be imported here. In addition, there is a 3.4¢/lb. import duty plus a 25½% *ad valorem* charge (tax above landed value) which together would add about 10½¢/lb. to the price of 25.6¢ British resin sold in the U. S. The I.C.I. capacity in the United Kingdom is listed at over 200 million pounds. The British price may well compete with American resin sold at a rate of 300 million lb. a year in other foreign countries. It seems that polyethylene prices are even lower in countries without a producer, since competition is more severe where all producing countries bid for the business. Along this line it is interesting to note that the Japanese government cut back to 100,000 tons its producers' applications for polyethylene capacity of 180,000 tons in 1962. Present capacity in Japan is 20,000 tons.

According to press reports, I.C.I. is also trying to sell polyethylene technology to the Soviet Union. West Europeans have been rather industriously engaged in such enterprises for more than a year. But the U. S. government has up to now refused to permit sale of polyethylene technology to the Russian government.

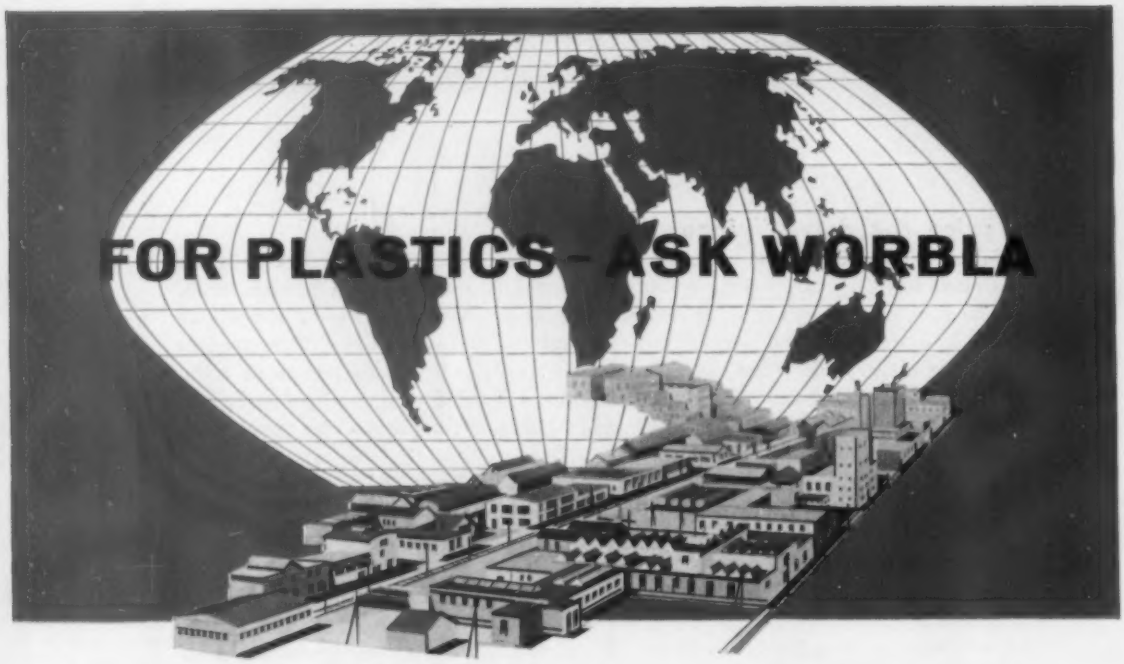
Polystyrene price scramble

The polystyrene price structure danced around like a whirling dervish all through December following Foster Grant's announcement in late November that cut the price of general-purpose crystal in quantity lots from 21½¢ to 19¢ a pound. Other companies got on the toboggan, and the price slipped to 18¢ for quantity lots and to 17¼¢ in bulk carloads. Other formulations, such as impact grades, v.i.p., special colors, and higher-heat-resistant resins were also reduced from ½ to 2¢ a pound. Prices in 1000-lb. containers were also changed, first by raising the premium 1¢, then reducing that by ½¢, and including impact as well as general-purpose.

As we go to press, Dow Chemical has announced that it was going to raise the price back up to 19¢ starting January 1, and eliminate a lot of variations. Thus its price will be 19¢/lb. in 50-lb. bags. The bag price is the same regardless of whether the order is for one bag or a boatload of bags. At the same time Dow has eliminated the premium price on 1000-lb. containers, so that the price is now the same in either container or bag.

In speaking on this subject, Mr. William R. Dixon, general sales manager of Dow, said that significant price reductions had been made in the last eight years based on improved skill and technology, but "recent price trends can not be so justified and are unhealthy for fabricator and supplier alike."

He continued, ". . . the majority of our customers are restricted to what amounts almost to a fixed percentage mark-up or a 'value added' concept in setting their prices. Thus, even at a constant profit margin, their ability to provide innovation



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WOPALIT — Acetate powder for injection molding and extrusion

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WORBLA — Nitrocellulose for lacquers and technical uses
Bleached linters

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and improvement in products has been seriously curtailed by the substantial fall in material price to date."

There will no doubt be more to say on this price situation in next month's column, when it is hoped the picture will be clearer.

Molder and packager merge

Worcester Moulded Plastics, Worcester, Mass., has joined Packaging Corp. of America, Evanston, Ill., to become the nucleus of P.C.'s new plastics division. There will be no changes in Worcester's operations or personnel, according to Horace Gooch and Philip J. Graham, co-founders of Worcester. The new arrangement will lead to an expansion of operations in the Worcester plant, which now employs nearly 300 persons.

Mr. Gooch will become vice-president of P.C. in charge of plastics, and Mr. Graham will head research, engineering, and machine development. In addition to injection molding, Worcester has become a large molder of expanded polystyrene for packaging. This is a companion material for P.C.-produced paperboard.

Packaging Corp. of America operates 49 plants in the U. S. with annual sales exceeding $138 million.

Nixon-Baldwin vinyls

Under license from an as-yet-unnamed European source, Nixon-Baldwin Chemicals Inc., Nixon, N. J., will shortly offer to the packaging and industrial thermoforming fields a new extruded high-gloss rigid vinyl sheet in regular and high-impact formulations. The sheet, in thicknesses ranging from 5 to 80 mils, will be produced on equipment currently being installed. It is available in pilot quantities now in transparent, translucent, and opaque varieties.

Allen J. Baldwin, president of the new company, is convinced that the impact and rigid vinyls, so widely accepted in Europe, are due for a market breakthrough in the United States. He aims to start with sheets for packaging, such as blister packs and boxes, and for thermoformed displays, and later to provide vinyl sheets for appliance, automotive, and business machine applications. Still later, rigid weather-resistant sheets for the building field are expected.

In addition to Mr. Baldwin, other officers are Zenas Crocker, vice-president; Walter G. Tucker, vice-president sales; William A. Olsen, vice-president sales; Charles C. Schlachtun, vice-president manufacturing; Joseph K. Schmitz, vice-president engineering.

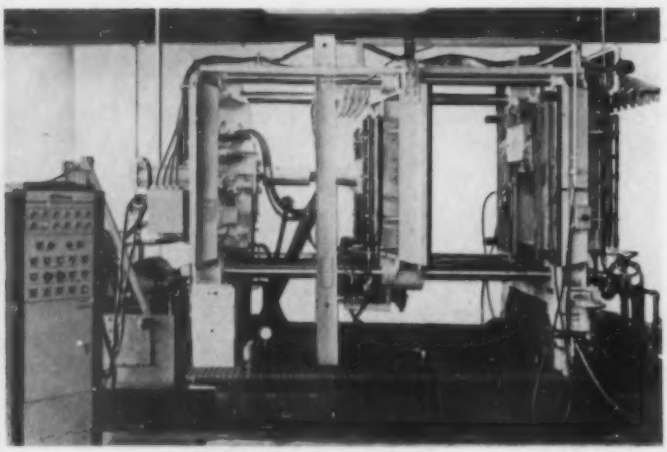
New producer of polyesters

Valchem, the chemical division of United Merchants and Manufacturers, Inc., plans to begin production of unsaturated polyester resins sometime in the spring of 1961 at a plant now under construction in Langley, S. C. Annual start-up capacity will be three million lb., but facilities can be easily expanded to a 12-million-lb. production figure. Primary market area will be the Southeastern states, where the plant's location will offer delivery and freight advantages, says Valchem.

For additional and more detailed news see Section 2, starting on p. 222

NEW MACHINERY-EQUIPMENT

Specifications, claims made, and prices appearing in these pages are those of the manufacturers or sellers of the machinery and equipment described, or their agents.*



Expandable polystyrene foam molder

Called the Millatron, this expandable polystyrene-foam molding machine can be operated automatically or manually. Oil pressures between 1000 and 2400 p.s.i. are used to provide fast closing of the molds and clamp pressure during expansion; low pressures between 300 to 400 p.s.i. are used for low-speed final mold closing and cracking for air purge. Solid mold platens are not used. Instead, a mold or multiple molds up to 15 in. deep are mounted with the parting line vertical on a grid system 66 in. wide and 42 in. high. The unit requires special molds to be supplied by the manufacturer; each mold is equipped with an automatic mold-loading device called the Millafill. These devices suck pre-expanded beads from feed bins and are designed to deposit the beads evenly and uniformly in the mold. Because each mold is fed separately, either molds for identical or different products can be run simultaneously where all parts have approximately the same wall thickness. With the above mounting system, molds can be changed in 10 to 15 minutes. The cycle sequence, with separate timer control on each segment, is as follows: 1) Mold closes completely and cracks open while being simultaneously preheated; 2) Steam is admitted to the cracked mold to purge the loading air and start fusion; 3) Molds are then clamped shut and expansion is completely under high clamp pressure; 4) After a controllable dwell, water cooling is applied; and 5) After cooling, the mold opens and molded foam part is air-ejected, falling free of the machine between the vertically mounted molds. A typical cycle is shown in accompanying table. A supply of clean air at pressures between 80 and 125 p.s.i., water at pressures between 80 and 100 p.s.i., clean dry steam between 100 and 150 p.s.i., and a vacuum of 10 to 25 in. of Hg. are required for the machine's operation. Matched auxiliary equipment to supply the above is available with the press as a packaged unit. Molds supplied for use with the machine are pre-tested by the manufacturer and are fully guaranteed to operate on cycles and under the conditions at which they are tested. Prices of standard and custom models are $38,000 and $40,000, respectively. Delivery is 6 to 8 weeks. *Miller & Van Winkle Co., Paterson 2, N. J.*

Typical Millatron cycle[a]

Steam pressure, psig.	
Female mold side, fixed	50
Male mold side, moving	40
Cycle times, sec.	
Preheat and close	10
Fill with pre-expanded beads	3
Weld	5
Dwell[b]	10
Cooling[c]	19
Press opening and ejection	3
Total cycle, sec.	50

[a] Molding a 1.5-oz. foam product with a foam density of 1.5 lb./cu. ft. and a wall thickness of 0.5 inch. [b]Time allowed for slight cooling to take place prior to full cooling with water to prevent collapse of foam. [c]Cooling under full water pressure.

Mold temperature controller

This compact unit automatically controls temperature of water for injection molds to a precision of plus or minus ½° F. It is only 20 in. long, 10 in. wide, and 10½ in. high. The very small size is possible because of a special water pump which supplies water at high velocity and in high volume without the use of bulky reservoirs. Water temperature may be increased or decreased in 1 to 2 min. by resetting dial control. Operating temperatures from 40 to 250° F. can be maintained. Mounted on coasters, the 100-lb. unit can be easily moved from machine to machine. Once water, drain, and electrical connections are made, it is ready for operation. Two dial thermometers show water temperature in and out of mold. *Mokon Div., Protective Closures Co. Inc., 2207 Elmwood Ave., Buffalo, N. Y.*

Blow molder

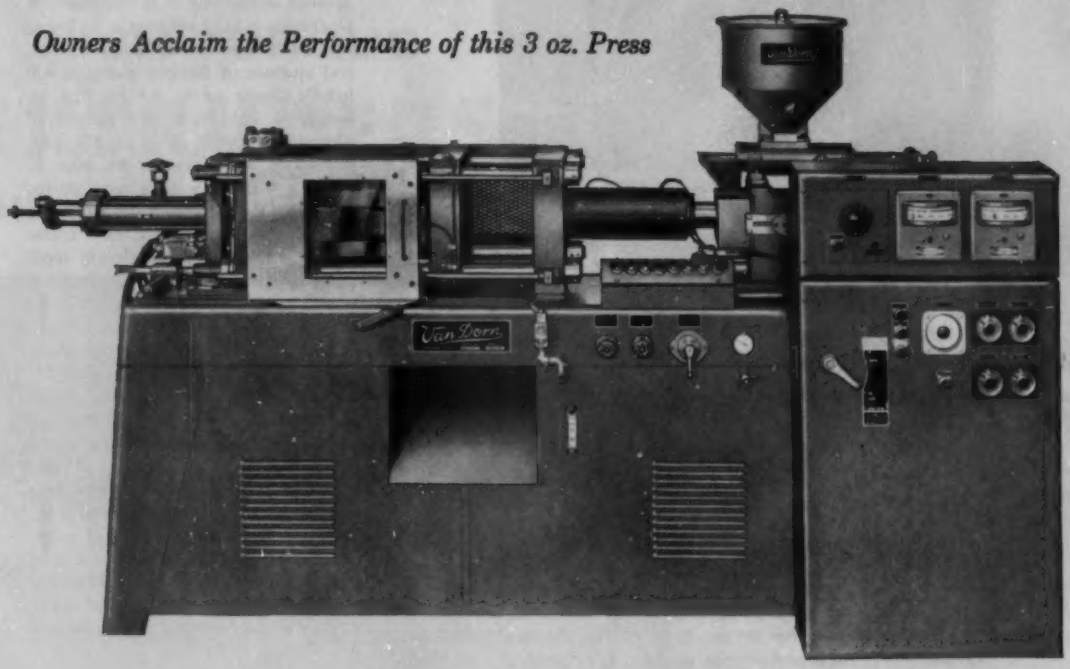
Items up to 13½ in. in diameter and 35 in. long can be blow molded on the Model E-21-OHP, single-mold station, twin-head machine. The production of these large parts is facilitated by the 1½-lb. capacity piston-type accumulator, which functions as a material reservoir, and is mounted between the extruding head and the die. Using the accumulator provides for the rapid delivery of a parison and a total plastic shot capacity of 56.5 cu. in., or 28.25 cu. in. from each head. A 2-in. extruder is supplied and will deliver 100 lb./hr. of plasticated melt to the accumulator. The machine can make parisons with diameters up to 6½ in. to a maximum of 36 in. long. Maximum mold daylight is 28 in. and mold stroke is 14 inches. Spacing between the four 1½-in. round tie bars is 21 inches. An air-oil hydraulic system controls the 10-ton die-closing force. Maximum extrusion plunger force is 12,250 pounds. The blow molder is designed to permit introduction of the blowing air to the parison at the top, bottom, or through the side of the mold. The unit has a photoelectric safety system and automatic ejection. *Modern Plastic Machinery Corp., 64 Lakeview Ave., Clifton, N. J.*

(More on page 48)

* Prices are deemed to be F.O.B. sellers' plants (unless otherwise stated), are for "standard" models, and are subject to change without notice. The publishers and editors of **Modern Plastics** do not warrant and do not assume any responsibility whatsoever for the correctness of the same or otherwise.

Because Model H-400 has proved so efficient . . . Customers have demanded a companion Van Dorn 3 oz. Plastic Press

Owners Acclaim the Performance of this 3 oz. Press



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HIGH CLAMPING PRESSURE— 100 tons

HIGH SPEED OPERATION up to 1100 dry cycles per hour

FAST MOLD SET UP—toggle assembly easily adjusted for mold thickness

ADJUSTABLE TOGGLE STROKE 4″ to 8″ Standard and 4″ to 12″ optional

LARGE PLATENS accommodate molds up to 12″ x 18″

FOUR TIE BARS

HYDRAULIC CYLINDER positions heater and injection mechanism for fast and convenient set up and purging

MAXIMUM OPERATOR PROTECTION with hydraulic and electrical interlock

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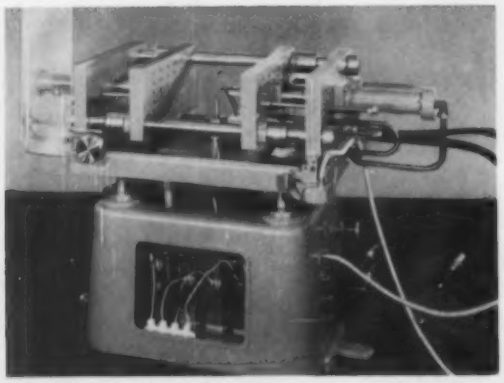
(From page 46)



EURO-MATIC MOLD Model BB 03 mold-clamping unit, showing single-mandrel version. The parison mandrel and mold platen platform rise to meet the descending parison from the extruder blow-molding head (not shown). After clamping, the parison is cut off, and the mold descends to its initial position for cooling. Air jets automatically eject the bottle.

Blow-molding machine for bottle production

The Euro-Matic Model BB 03, rising-mold type, blow-molding machine has been designed for heavy-duty, continuous blown bottle production. An actual installation in the field has run over 7000 hr. in 3-shift operation without a single breakdown. The machinery is supplied without extruder or cross head, and consists of three separate components: a mold-clamping unit, a hydraulic power pack, and a control console. These are designed to provide maximum installation flexibility. The mold-clamping unit can be supplied with 1, 2, or 3 bottle-neck mandrels (with or without water cooling) and will handle up to three molds. Bottles as large as 1 gal. in capacity can be made on a single-mold, single-mandrel set-up and up to three bottles of smaller size on the multiple-mandrel machine. Typical of the production rates which can be achieved: a 10-oz. bottle, 2 in. square by 6 in. high, run at a rate of 500/hr. Cycles as fast as 3000/hr. are possible on small containers using 3-mold operation. Blowing air at 90 to 150 p.s.i. is required at a rate of 3.5 to 5.3 cu. ft./min. The bottles issue from the machine fully finished, with flash that can be stripped away by hand. The vertical movement of the platen is fully adjustable within the limits of the machine, as is the clamp stroke, so that operating movements can be minimized for optimum cycles. Bearings for both the mold platens and the vertical movement cylinder are made of graphite-filled nylon. Extruders with screw diameters of 2 to 2½ in. are recommended for use with the unit and should have L/D ratios of 18 to 20. For small bottle production the extruder should be capable of delivering 40 lb./hr.; for larger bottles, 90 lb./hr. of material should be available. Suitable cross heads for the unit can be obtained from the blow-molding machine manufacturer. The hydraulic power unit uses Vickers equipment and requires an electrical supply of 380/220 v. of 50 or 60 c.p.s. Oil can be cooled with the mold-cooling exhaust water. The control panel is a compact 28 by 14 by 18 in. in size and, among the other required controls, contains a cycle or parts counter. Price for complete 3-part unit is about $7800 F.O.B. Sweden; delivery time about 15 to 18 weeks. For other specifications of this equipment see table to left. *European Plastic Machinery AB, Baltzarsgatan 29, Malmoe C, Sweden.*

Major specifications: Euro-Matic blow molder

Mold clamp force, lb.	
With standard cylinders	3000 to 5000
With oversize cylinders	4300 to 7500
Approximate platen speeds, in./sec.	
Closing speed	6.3
Opening speed	9.8
Mold platen dimensions, in.	
Height	10
Width	22
Mold space between platens, in.	
Minimum	3.9
Maximum	18.1
Maximum mold dimension, in.	
Height	12.6
Width	15.75
Rising mold speed, in./sec.	12.6
Maximum vertical movement, in.	14.2
Maximum mandrel diameter, in.	2.56

Thermoformer

The Formpack R-4 is a completely automatic multi-stage rotary thermoforming machine suitable for the continuous production of thin-walled thermoplastic items made of sheet or film. It can do deep-drawing, drape-forming, or drop-forming either as individual operations or in combination. Operation is fully automatic, including feeding of stacked sheets or roll stock, and ejection of finished parts. It will handle sheets up to 9.8 by 11.8 in. and up to 0.012 in. thick at the rate of one sheet very 3, 3½, or 3¾ sec., depending on thickness. An edge of material 0.16 in. wide is required for clamping and the forming area can be reduced steplessly. Clamp frame force is 5500 pounds. Maximum depth of draw is 6 inches. Preprinted roll film feeds are automatically indexed and rolls up to 40 in. in diameter and 10.16 in. wide can be handled. Heating of the sheet is done by either 16- or 24-kw. heaters. All forming operations are controlled through the use of mechanical cams. Unit requires an 85-p.s.i., 30-cu.-ft./min. source of compressed air. Typical production rates are 14,000 cups with a 2:8-in. trim diameter on a 12-cavity mold every 3 sec.; or 86,000 lids with a 1.2-in. trim diameter made on a 72-cavity mold every 3 seconds. *Hydro-Chemie Ltd., Dreikoenigstrasse 21, Claridenhof, Zurich, Switzerland.*

Extruder

Known as the Rainville Extruders, these machines are designed for heavy-duty, high-speed production of all types of plastic materials and are constructed with Xalloy one-piece cylinder, shaft-mounted gear drive, and chromium-plated extrusion screw. They are complete with all electrical and plumbing connections. Stainless steel covers on the barrel are standard. Sizes available are 1½, 2½, 3½ and 4½ in., in 20:1 L/D ratio. Vented and extra-long barrels and special bases are available on special order. *The Rainville Co. Inc., 839 Stewart Ave., Garden City, N. Y.*

(More on page 50)

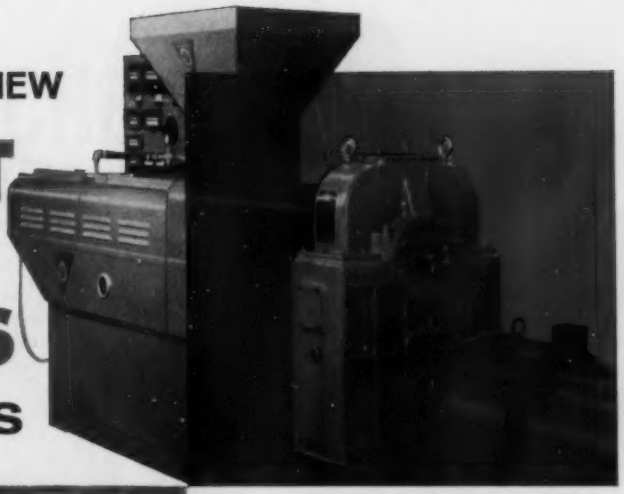
Years Ahead! The VERSATILE, NEW

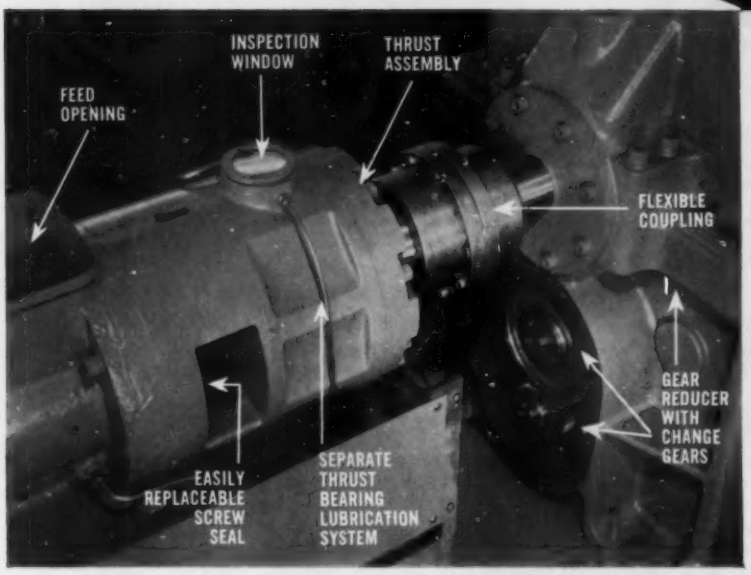
PRODEX HT

HIGH TORQUE

EXTRUDERS

with CHANGE GEARS





BOTH HIGH AND LOW VISCOSITY MATERIALS CAN NOW BE EXTRUDED AT MAXIMUM H.P. EFFICIENCY AND OUTPUT

LOOK AT THESE HORSEPOWER RATINGS

EXTRUDER SIZE	HORSEPOWER RATINGS
1¾"	7½-10
2½"	20-40
3½"	40-100
4½"	60-150
6"	125-200
8"	200-400

The versatile PRODEX **HT** EXTRUDER gives you the opportunity to quickly select the optimum reduction ratio and screw speed necessary to achieve the highest possible production rate for each extrusion job.

This is now possible because the new PRODEX gear reducer with change gears is capable of transmitting as much torque as the screw can handle. All plastic materials can now be run at maximum output and horsepower efficiency of the motor drive.

Let us show you **all** the new features incorporated in the new PRODEX **HT** EXTRUDER. See it perform with your own materials in our customer service laboratory. Write or phone for appointment.

ONLY PRODEX HAS ALL THESE DESIGN FEATURES

- GEAR REDUCER: Vertical design for space saving and extra ruggedness. Herringbone gears thruout.
- CHANGE GEARS: For selection of the optimum reduction ratio and screw speed at any time.
- SEPARATE THRUST ASSEMBLY permits easy accessibility and maintenance. The spherical roller thrust bearing used in all machines is self aligning.
- SEPARATE THRUST HOUSING LUBRICATION SYSTEM: Oil is continuously circulated by a gear pump through a filter cartridge. Best bearing oil can be used. No compromise between gear and bearing lubricant as in other machines.
- FLEXIBLE COUPLING to absorb thermal expansion misalignment between gear reducer and extruder. Avoids any possible thrust load on gear reducer.
- FULL DIAMETER SCREW SHANK to handle heaviest torque load.
- INSPECTION WINDOW on thrust assembly housing permits visual bearing and oil feed inspection.
- EASILY REPLACEABLE SCREW SEAL to prevent leakage of dusty powders and for use of vacuum hoppers and melt feeds.
- FEED OPENING: Large rectangular opening with cooling jacket. Permits feed to flow freely.
- SELF CENTERING cylinder front support greatly reduces cylinder and screw wear.
- FULL LENGTH HEAVY MACHINE BASE
- FULLY AUTOMATIC heating and cooling controls.
- SIZES: 1¾" to 8" diam. L/D ratios 20:1, 24:1 and 30:1.
- SINGLE AND MULTIPLE STAGE VENTING
- CONTROLLED PRESSURE VALVING
- INLAY HARD-SURFACED SCREWS (not flame hardened) keep their hardness through highest extrusion temperatures.

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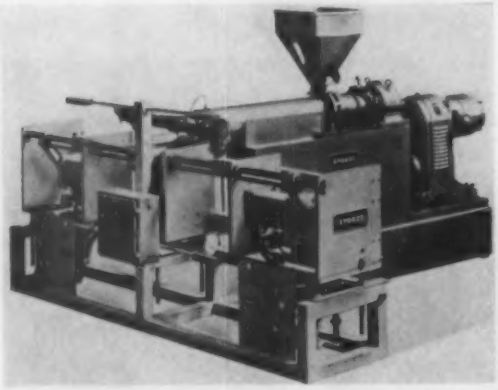
NEW MACHINERY-EQUIPMENT

(From page 48)



STOKES MODEL 856 dual-manifold blow molding machine and matching 3½-in. extruder, showing single-parison delivery heads that are installed on standard models.

Two-station blow molder for large items

Designated Model 856, this dual-manifold, two-station blow-molding machine is capable of molding plastic products as large as a five-gal. container, or other large items using a comparable weight of polyethylene, polystyrene, and other plastic materials. It has been designed for the efficient use of a 3½-in. extruder. Self-contained clamping system is hydraulic, but machine can be supplied for air power if desired. A single large cylinder actuates the two platens for each molding station through a system of tie and push rods. This assures uniform closing rates for both halves of the mold, and the special linkage equalizes the movement of the two platens so that they clamp the molds together at the exact center of the molding station. An air-operated two-way valve alternates material flow from station to station. Optional, as extras, are dual-extrusion cross-heads which provide delivery of two parisons at each mold station. Also available is a 4-lb. accumulator for use between extruder and manifold to provide rapid parison delivery. The unit may be purchased with or without a matching Stokes extruder. Other specifications are shown in accompanying table. *F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.*

Specifications: Stokes Model 856 blow-molding machine

Clamp force at 100 p.s.i., tons	5
Stroke (each platen), in.	13
Daylight (mold open), in.	28
Platen width, in.	20
Platen height, in.	27½
Mold width, max., in.[a]	14
Mold height, max., in.[a]	17½
Maximum mold length, in.	36
Mold length clearance, in.	50
Maximum part diameter, in.	12¾
Maximum part diameter, in.	30
Dry cycles, cycles/hr.	1000
Normal extruded parison delivery rate, lb./min.	12
Parison delivery with accumulator, lb./min.[b]	80

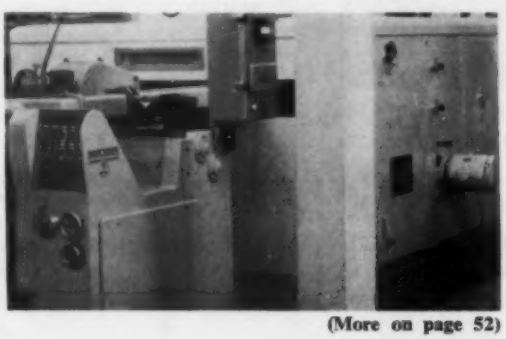
[a]Distance between tie bars. [b]Accumulator is optional extra.

Pipe extruder

Intended especially for the extrusion of rigid PVC pipe directly from dry blend, this 2½-in. Prodex Vented Extruder has a specially modified screw. It is also supplied with a new type die developed for the exact sizing of the pipe to close tolerances and to insure high-gloss finish on both the inside and outside of the pipe. The extruder manufacturer is also recommending the special rigid PVC dry blend formulation and the use of a Prodex-Henschel mixer for the rigid pipe extrusion line. The unique combination of the mixer, the formulation, and the special extruder is a prerequisite for the successful extrusion of the rigid PVC pipe from the dry blend by this process. The vented extruder has an L/D ratio of 24:1 and the venting eliminates porosity due to air, moisture, or other causes. The rigid polyvinyl chloride pipe process consisting of dry blend mixer, PVC formulation, extruder, and take-off equipment is being offered as a package unit. *Prodex Corp., Fords, N. J.*

Stretching machine for calendered and extruded film

Many types of plastic film can be stretched on the Bruckner Film Stretching Machine. Stretching calendered or extruded film at controlled temperatures can improve strength, transparency, and surface quality or be used to develop special effects. Stretching also reduces the relative magnitude of thickness variations and can be used to produce web widths wider than those possible on existing extrusion equipment. In the stretching machine, the film enters the unit over tensioning and guide rollers and is gripped at its edges with tenter clips. The film is then heated with hot air to the proper temperature (temperature varies by type of film), and is stretched by the diverging tenter clips. After passing through a cooling zone, the film is wound or rewound. In addition to stretching across the web, the machine can be supplied with optional equipment which will also then stretch the film in the direction of web travel. This two-stage process should not be confused with true biaxial orientation, which stretches the film simultaneously in two directions. Such a stretching machine is under development but is not as yet available. Typical stretching ratios which have been used on the Bruckner machine are 2:1 on polyethylene, 4:1 on PVC and polycarbonate film, and 8:1 and greater on polypropylene films. Average air temperatures used were 210 to 230° F., with some running as high as 390° F. Average web speeds were 30 to 35 yd./min. Speeds up to 100 yd./min. are said to be possible. The length of the machine can be supplied according to need. All machines are adaptable on order to the particular application. *Bruckner Machinery Corp., Cedar Grove, N. J.*



BRUCKNER Foil Stretching Machine showing feed end (left) with controls. Horizontal scale (top, left of center) indicates amount of transverse stretch of film.

(More on page 52)

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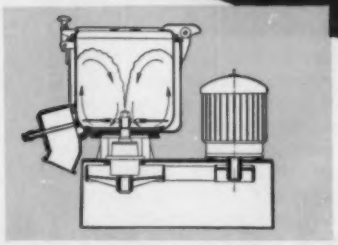
MIXER for INTENSIVE

- ✓ Resin Dryblending
- ✓ Pigment Dispersion
- ✓ Mechanical Heating

of resins and compounds in EXTREMELY SHORT CYCLES WITH EXCELLENT UNIFORMITY!



In the **PRODEX-HENSCHEL MIXER,** a specially designed propeller-like impeller rotates at peripheral speeds of about 150 ft/second. The centrifugal action of this impeller creates a rapid and continuous flow of the mixer charge through the impeller blades. The high impact velocity of the blades and their shearing action break down agglomerates and cause intimate dispersion of all ingredients. The impeller is designed for large energy transfer to the mixer charge so that rapid mechanical heating is also obtainable. The heating rate is controlled by selection of the proper speed on the multiple speed motor drive. Mixing cycles for complete dispersion are usually so short that heat build-up is negligible where it is not desired. The mixers are jacketed for heating or cooling, and a stock temperature indicator is provided for continuous observation of the batch temperature.

Hundreds of PRODEX-HENSCHEL MIXERS are being successfully used for...

- ✓ **Plasticized Vinyl Dryblending**
- ✓ **Rigid PVC Dryblending**
- ✓ **Pigment Dispersion in Polymers**
- ✓ **Acetate and Butyrate Dryblending**
- ✓ **Filler Mixing with Thermosets**
- ✓ **Fibre Mixing with Polyesters**
- ✓ **Dry Coloring**

PRODEX-HENSCHEL MIXERS ARE AVAILABLE IN FOUR SIZES

MODEL	2JSS	18JSS	35JSS	115JSS
TOTAL CAPACITY (cu. ft.)	0.37	2.7	5.3	17.5
USEFUL CAPACITY (cu. ft.)	0.25	1.8	3.5	11.5
MOTOR H.P.	2	15	32	92

Also available in vacuum-tight construction for vacuum extraction with large material surface exposure and continuous agitation.

The **PRODEX-HENSCHEL MIXER** is cleaned in minutes, due to its smooth interior design. All contacting surfaces are made of stainless steel. It is easily loaded and discharged while running.

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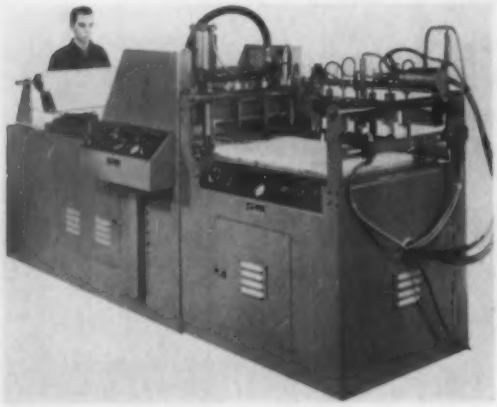
NEW MACHINERY-EQUIPMENT

(From page 50)



COMET BLIST-O-MATIC vacuum forming-slitting machine. Circular cutters (center) slit in the direction of the moving formed sheet; others (at right background) make transverse cut at right angle to complete rectangle. Minimum cross-cut dimensions are 1 inch.

Vacuum former-slitter for thermoplastic sheet

Suitable for the production of containers, lids, flower pots, cups, and other items to be made of thermoplastic sheet, the Blist-O-Matic can form and trim items up to 5½ in. high at speeds of 6 to 10 cycles/min. Full forming area is 24 by 32 inches. Minimum formable size is a 1-in. cube. Slitting is done at cutters which move at right angles to each other, cutting both in the direction of sheet feed and transverse to it. Trimming is limited to rectangular items. For round items, the slitting attachment may be replaced with a die-cutting press. After trimming, finished parts are automatically ejected from the machine. Products may be thermoformed by either plug-assist, drape, cavity forming, or air form methods. Air form is a combination of vacuum and air-pressure assist forming. Machine design is sufficiently flexible for integration with other production line equipment. *Comet Industries, 9865 Franklin Ave., Franklin Park, Ill.*

Multi-station rotary thermoformer

Called the Rotor Blow Matic, this rotary mold table, pressure thermoforming machine was specially designed for making refrigerator door liners and other large items. Pieces up to 8 in. deep and up to 62 by 31 in. in size can be formed from heavy sheet. Fully automatic in operation (except for loading and unloading of sheets), the table has four sheet clamping stations. After the sheet is clamped, it goes to a pre-heat station, then to a full-heat station, and thence to a forming station. Here a 12-hp. hydraulic arbor press clamps and seals the sheet, forming it into the mold with hot air at a pressure of 5 atm. The press then automatically trims the sheet and drills it when required. Typical hourly production is 120 PVC door liners, 2-mm. thick, fully trimmed and drilled. Dry cycle is up to 300 pieces per hour. Heaters supply 2 kilowatts. *A. Triulzi, Via Vialba 56, Novate (Milano) Italy.*

Automatic transfer press

Specifically intended as a low-cost unit for use on short production runs where low mold costs and quick set-up are desired, 25-ton air-operated automatic transfer-molding press, Model 725, also provides the labor-saving advantages of automatic molding. It is easily converted from automatic transfer molding to automatic compression molding, and it can be operated either fully automatically, intermittently, manually, or semi-automatically. Press operates with direct powder feed by means of an easily adjustable three-station rotary feeder. An air supply with 100 p.s.i. working pressure is ample. The force of the air-cylinder is multiplied by a toggle arrangement to develop the 25-ton clamping force and provides fast closing and opening action. A 5½-ton maximum transfer force is obtained by means of a separate air-cylinder, whose pressure can be adjusted independently of the clamping pressure. The unit is supplied with both top and bottom ejection systems, and has an air-operated blow-off device. Other specifications: clamp stroke, 5 in.; transfer stroke, 2½ in.; ejection stroke (top and bottom), 2½ in.; hold-down pin stroke, 1¼ in.; daylight, press open, 22½ in.; daylight, bed plate to ram with press closed, 12 to 17 in.; platen size, 11½ by 6 in.; minimum dry cycle time, 5 seconds. *F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.*

Bottle-bottom coder

A portable conveyor-line attachment for imprinting the bottom of plastic bottles employs a new kind of flexographic ink that is said to adhere permanently to the treated plastic surface. The coder automatically separates and holds the bottles as they are imprinted; bottles may be empty or filled; feed may be continuous or intermittent. *Adolph Gottscho Inc., Hillside, N. J.*

Weigh feeder

Developed especially for small-capacity injection machines, the Type 6130 precision weigh-feeder has a maximum weigh bucket capacity of 10 ounces. It is designed to be mounted on the molding press in place of the regular volumetric hopper. The unit includes a scale with over-and-under indicator, a 50-lb. capacity aluminum supply hopper, and stainless steel net weigh hopper and dump mechanism. Fully electrical in operation, the unit requires 115 v., 60 c.p.s. current at 50 watts. *Exact Weight Scale Co., 538 East Town St., Columbus, Ohio—End*

FERRO'S Brand New

UNIROVING

The industry's finest roving, long used *exclusively* for production of Ferro Uniformat and Unirove reinforcing materials, is now available to thermosetting molders. To our friends who have waited for this day, after "trial runs" while we were expanding production facilities, we want to express sincere thanks. And we promise to deliver the same *high quality, consistently uniform* roving they found so satisfactory in their tests. If you are interested in such material, we invite you to try UNIROVING. Write for samples, specifications, prices.

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WORLD-WIDE PLASTICS DIGEST

Abstracts from the world's literature relative to plastics. For complete articles, send requests direct to publishers. List of addresses is at end of this section.

General

New contenders groom for plastics jobs. Chem. Week *87,* 105-06, 108 (Oct. 15, 1960). Three new plastics are described briefly. They are polyspiroacetals, trans-polyolefins, and polyoxetanes.

Fibers. C. S. Grove Jr., J. L. Vodonik, and R. S. Casey. Ind. Eng. Chem. *52,* 959-61 (Nov. 1960). Developments in synthetic fibers are reviewed; 98 references.

Materials

Sucrose acetate isobutyrate in cellulose acetate plastics. W. M. Gearhart and E. W. Wilson. SPE J. *16,* 1140-43 (Oct. 1960). Sucrose acetate isobutyrate (SAIB) improves the end products and the processing characteristics of cellulose acetate (CA) plastics. SAIB is of considerable value as a modifier in the field of dimethyl phthalate plasticized CA. Several other applications are also described for SAIB-modified plastics.

Ultra-violet absorbers stop degradation. D. Weicksel. Canadian Plastics *1960,* 47-49 (Oct.). Substituted 2-hydroxybenzophenones are useful as absorbers of ultra-violet radiant energy to prevent degradation of plastics. Particular emphasis is given the compound 2,2'-dihydroxy-4-methoxybenzophenone. This material exhibits a cut-off in the ultra-violet at 380 millimicrons. The use of this compound is beneficial in films, lacquers, and varnishes containing polyvinyl chloride, polyvinylidene chloride, polyvinyl butyral, and cellulose acetate.

Mechanism of the thermal hardening of phenol-formaldehyde resins. Z. S. Smirnova and V. I. Serenkov. Vysokomolekuliarnye Soedineniia 2, 1067-70 (July 1960). The thermal hardening of resols is due to interaction between methyl groups and the hydrogen of the ring. The hydroxyl groups of phenol do not participate chemically in the hardening process. The phenol hydroxyls undergo no change when novolaks are heated to 180° and even to 250° C. Heating the latter to 350° C. leads to their degradation.

Effect of fillers on the melting points of crystalline polymers. V. A. Kargin and T. I. Sogolova. Vysokomolekuliarnye Soedineniia 2, 1093-98 (July 1960). A study was made of the melting points and mechanical properties of crystalline polymers compounded with solid fillers. The addition of a filler not entering into chemical reaction with the polymer does not shift its melting point, i.e., it does not break down the structure of the primary crystalline regions. It does, however, change the complex of the mechanical properties, i.e., it affects the secondary crystalline formations. On chemical interaction between the filler and the polymer, the melting point of the latter is lowered. The filling of a crystalline polymer with large amounts of metallic oxides causes a qualitative change in the properties of the polymer at temperatures above the melting point.

Molding and fabricating

Molding flexible polyether urethane foams. P. G. Gemeinhardt, J. F. Szabot, A. S. Morecroft, and J. H. Saunders. SPE J. *16,* 1117-19 (Oct. 1960). A process for molding thin sections of one-shot polyether foams is described. The molds are constructed of 16-gage steel, but thin aluminum may also be used. Rapid foaming is obtained in high capacity, radiantly heated ovens. This system for application of heat is said to practically eliminate foam densification.

Effect of orientation on the physical properties of injection moldings. G. B. Jackson and R. L. Ballman. SPE J. *16,* 1147-52 (Oct. 1960). A method is described for determining birefringence of molding resins. The information so obtained is useful in molding control and for rapid, nondestructive estimates of physical properties at various points of the molding operation.

Applications

Add plastics to corrosion foes. Chem. Eng. *67,* 104, 106, 108 (Oct. 17, 1960). Reinforced-plastic corrosion-resistant equipment has grown from almost nothing 5 years ago into a $7,000,000 business. Present growth is about 15% per year but a sudden spectacular expansion is expected by many. Potential market of process equipment is estimated at over $100,000,000 per year before installation. Polyesters account for about 90% of the equipment. Reaction products of maleic or phthalic anhydride and aliphatic glycols are making a strong bid for use in these reinforced plastics products. Chlorinated dicarboxylic acids are used along with materials such as hexachloroendomethylene tetrahydrophthalic anhydride to develop flame resistance.

Properties

Plastics and rubbers under extreme operating conditions. E. W. Russell. Plastics Inst. Trans. *28,* 164-70 (Aug. 1960). The behavior of plastics and rubbers in tropical, chemical, high temperature, low temperature, and ablative environments is discussed. Modes of failure are considered. Eleven references.

Testing

Testing and evaluation of dirt-resisting properties of PVC leathercloth and sheeting. F. Kratschmann. Kunststoffe *50,* 534-35 (Sept. 1960). Polyvinyl chloride leathercloth and sheeting tend to get slightly dirty in use. By application of a suitable dry and hard top coat, good dirt repellant properties can be achieved. A method is described to test this property.

Controlling materials for missile construction. M. Kushner. Brit. Plastics *33,* 361 (Aug. 1960). Although many new testing devices and test methods have been developed for analysis of reinforced plastics used in missiles, many become useless due to lack of control in preparation of the laminates. Areas in which greater quality control are required, and some of the problems which must be solved, are discussed in detail.

Publishers' addresses

British Plastics: Iliffe and Sons Ltd., Dorset House, Stamford St., London SE1, England.

Canadian Plastics: Monetary Times Printing Co. Ltd., 341 Church St., Toronto 2, Ontario, Canada.

Chemical Engineering: McGraw-Hill Digest Publishing Co. Inc., 330 W. 42nd St., New York 36, N. Y.

Chemical Week: Ibid.

Industrial and Engineering Chemistry: American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C.

Kunststoffe: Karl Hanser Verlag, Leonard-Eck-Strasse 7, Munich 27, Germany.

Plastics Institute Transactions and Journal: The Plastics Institute, 6 Mandeville Pl., London W1, England.

SPE Journal: Society of Plastics Engineers Inc., 65 Prospect St., Stamford, Conn.

Vysokomolekuliarnye Soedinenia: Academy of Science of U.S.S.R., Moscow, Russia.—End

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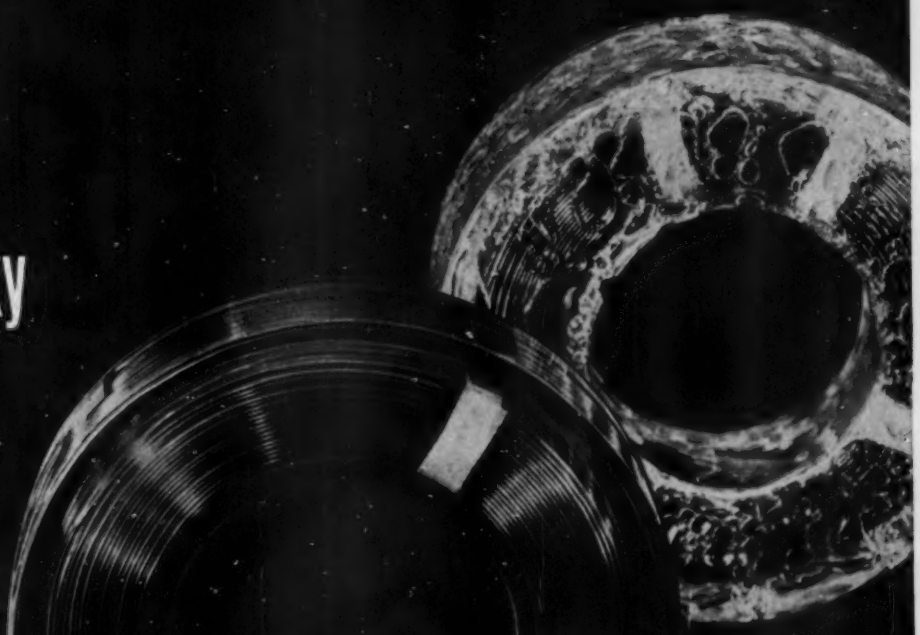

Typical casting made with ordinary low-viscosity epoxy containing volatile diluents that foam out at room temperature under vacuum.

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U.S. PLASTICS PATENTS

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U.S. Pats., Sept. 13, 1960

Polyisocyanates. W. Bunge, E. Windemuth, and K. Mielke (to Mobay and Bayer). 2,952,665.

Phosphoro-polyesters. H. W. Coover Jr. and R. L. McConnell (to Eastman Kodak). 2,952,666.

Polyamides. J. R. Caldwell (to Eastman Kodak). 2,952,667.

Copolymers. F. A. Ehlers (to Dow). 2,952,668.

Perfluorocarbon polymers. M. I. Bro (to Du Pont). 2,952,669.

Olefin polymers. J. E. Cottle (to Phillips). 2,952,671.

U.S. Pats., Sept. 20, 1960

Polyurethane foams. A. Khawam (to Allied Chemical). 2,953,533.

Foundry resin binder. H. K. Salzberg and C. R. Barber (to Borden). 2,953,535.

Aminotriazine-formaldehyde. G. Widmer (to Ciba). 2,953,536.

Vinyl halide polymer. W. K. McBrien (to Diamond Alkali). 2,953,537.

Curing glycidyl polyethers. R. M. Hedrick (to Monsanto). 2,953,544.

Cross-linked vinyl resins. J. A. Patterson and I. M. Abrams (to Chemical Process). 2,953,547.

Polyamides. S. Schott and H. Greenberg (to Natl. Distillers). 2,953,548.

Vinyl-epoxy copolymers. F. C. Frostick Jr. and B. Phillips (to Union Carbide). 2,953,550.

Ethylene-alkyl acrylate copolymer. W. G. White (to Union Carbide). 2,953,551.

Ethylene-alpha-butene copolymers. G. B. Stampa and M. J. Starck (to Union Carbide). 2,953,552.

Heteropolypeptides. W. A. Darlington and H. I. Weingarten (to Monsanto). 2,953,558-9.

U.S. Pats., Sept. 27, 1960

Polyvinyl fluoride film. L. R. Barton (to Du Pont). 2,953,818.

Polyacrylate copolymer-polyepoxide. M. D. Hurwitz (to Rohm & Haas). 2,954,358.

Trifluorochloroethylene copolymer. L. E. Robb and D. R. Wolf (to Minnesota Mining). 2,954,359.

Condensation resins. H. Krzikalla, F. Meyer, and F. van Taack-Trakranen (to Badische Anilin). 2,954,360.

Unsaturated borazol polymers. S. J. Groszos and S. F. Stafiej (to American Cyanamid). 2,954,361.

Vinyl chloride resins. I. E. Wilson (to Union Carbide). 2,954,362.

Halo-vinyl resins. W. Kuehne, H. Pohlemann, and H. Krzikalla (to Deutsche Advance Produktion). 2,954,363.

Polyester amides. D. Coleman, D. Kraszner, and A. F. McKay (to Monsanto). 2,954,364.

Polyisocyanates. E. Windemuth, W. Bunge, and O. Bayer (to Bayer and Mobay). 2,954,365.

Borazole copolymers. J. J. Pellon (to American Cyanamid). 2,954,366.

Polyvinyl compounds. E. J. Vandenberg (to Hercules). 2,954,367.

Polyetheneoxy esters. J. V. Karabinos and A. T. Ballun (to Olin Mathieson). 2,954,369.

U.S. Pats., Oct. 4, 1960

Extrusion. R. Colombo (to Lavorazione Materie Plastiche). 2,954,581.

Molding press. H. R. Gregory and M. Kendal (to British Coal). 2,954,583.

Molding press. W. R. Groves (to British Industrial Plastics). 2,954,584.

Sprayable foams. S. R. Foster (to Du Pont). 2,955,058.

Acetal compositions. D. E. Hudgin (to Celanese). 2,955,092.

Polyurethanes. F. Gollob (to Du Pont). 2,955,095.

Perfluorocarbon polymers. R. S. Mallouk and B. W. Sandt (to Du Pont). 2,955,099.

Curing polyepoxides. P. Bruin and J. J. Zonsveld (to Shell). 2,955,101.

Chlorinated isoolefin-polyolefin copolymers. R. E. Clayton, J. R. Briggs, and F. P. Baldwin (to Esso). 2,955,102.

Metal-plastic laminates. L. B. Allen and D. E. McElroy (to International Resistance). 2,955,974.

Cellular polyurethane. A. Khawam (to Allied). 2,956,031.

Siloxane foams. R. L. Joyce (to Dow Corning). 2,956,032.

Lignin-phenolic resin compositions. A. Apel and T. Riehm. 2,956,033.

Epoxy resin. L. J. Novak and J. G. McCallum (to Union Carbide). 2,956,039.

U.S. Pats., Oct. 11, 1960

Dyeing stressed polymers. P. W. Morgan (to Du Pont). 2,955,324.

Foundry resins. J. S. Horn and J. M. Bleuenstein (to Ford and American-Marietta). 2,955,336.

Chalkboard. F. B. Shaw, J. S. Schlueter, and J. R. Guenther (to Continental Can). 2,955,364.

Patching material. I. A. Herbst (to A. O. Smith). 2,955,952.

Furfural-aldehyde condensates. K. Dietz and G. M. R. Lorentz (to Lucius & Bruning). 2,956,040.

Polyethylene-polypropylene film. W. F. Underwood and E. D. Fuller (to Union Carbide). 2,956,042.

Quaternized polymers. H. E. Railsback and W. B. Reynolds (to Phillips). 2,956,043.

Acryloxymethylsilicon polymers. R. L. Merker (to Dow Corning). 2,956,044.

Polyacrylates. F. J. Glavis, D. G. Downing, and H. M. Grotta (to Rohm & Haas). 2,956,046.

Vinylidene chloride-acrylonitrile copolymers. W. G. MacPherson and C. D. Parker (to Dow). 2,956,047.

Fluoroolefin copolymers. A. N. Bolstad and F. J. Honn (to Minnesota Mining). 2,956,048.

Poly-alpha-chloracrylates. H. D. Anspon and F. E. Pschorr (to General Aniline). 2,956,049.

Polyethylene. C. J. Benning (to W. R. Grace). 2,956,050.

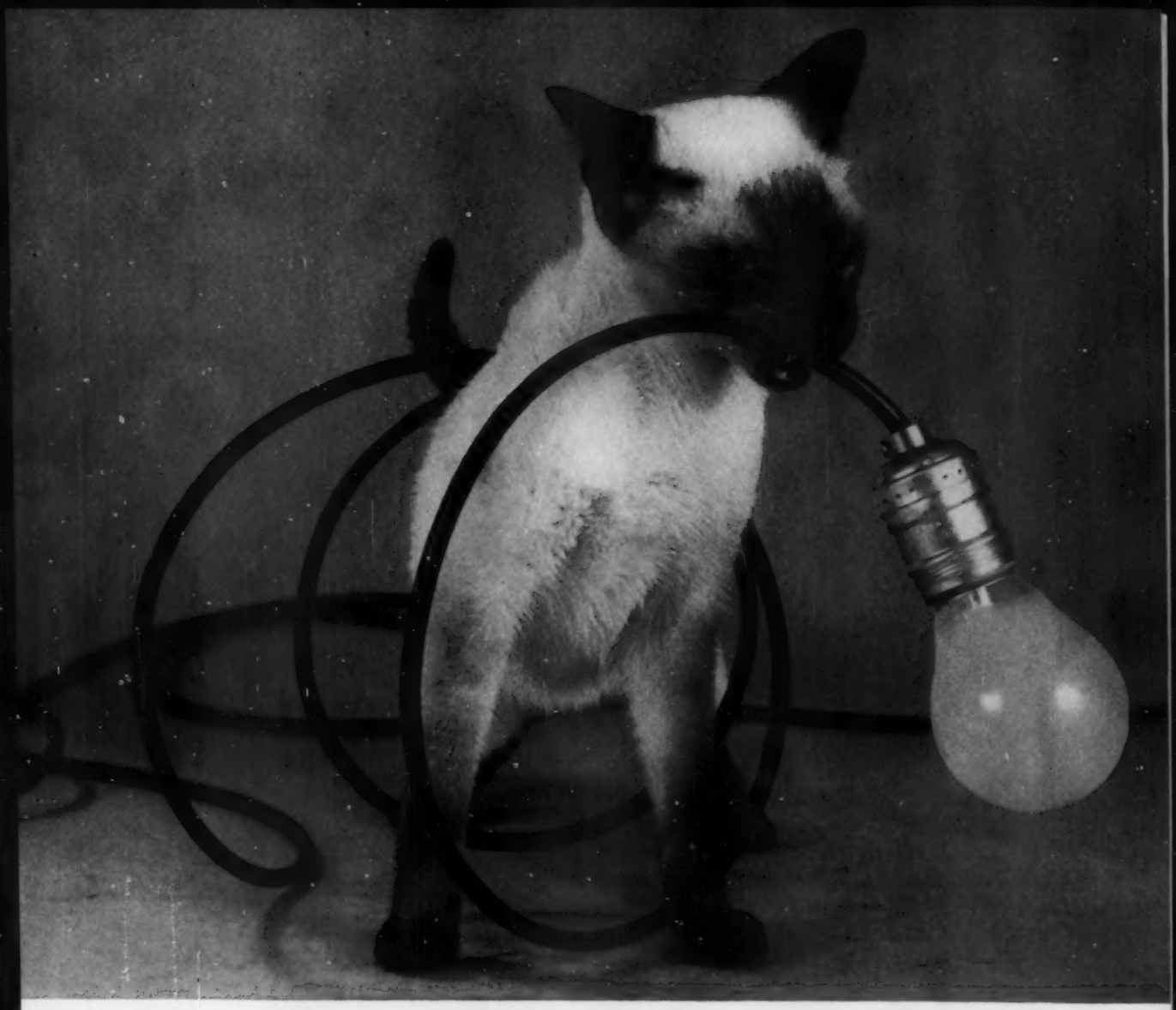
U. S. Pats., Oct. 18, 1960

Plastic boat. J. G. Newsome (to Newsome Fiberglass). 2,956,292.

Polyethylene extrusion. Y. Conwell, W. B. Happoldt Jr., and E. Lewis (to Du Pont). 2,956,306.

Hollow balls. A. L. Jendrisak and A. A. Jendrisak (to Brittain Products). 2,956,611.

Photosensitive polymers. M. J. S. Michiels, R. P. J. G. Thiebaut, and G. A. Philpot (to Eastman Kodak). 2,956,878.—**End**



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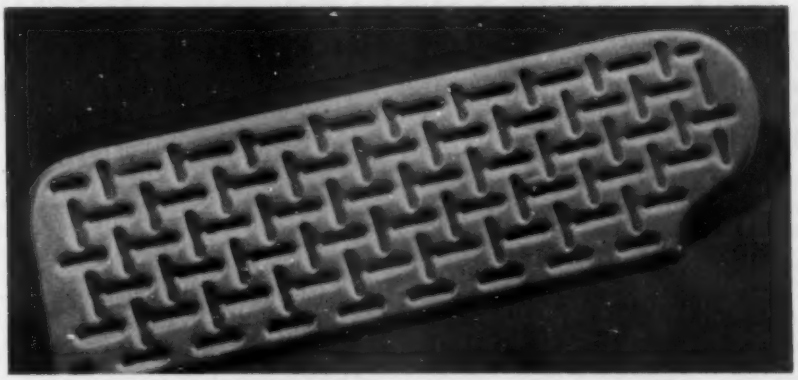

The heater ducts (left) were blow molded for the Chrysler Corporation by Woodall Industries, Detroit, Michigan. **Prototype blow-molded sun visor (above)** also by Woodall illustrates the design flexibility of blow molding for automotive applications.

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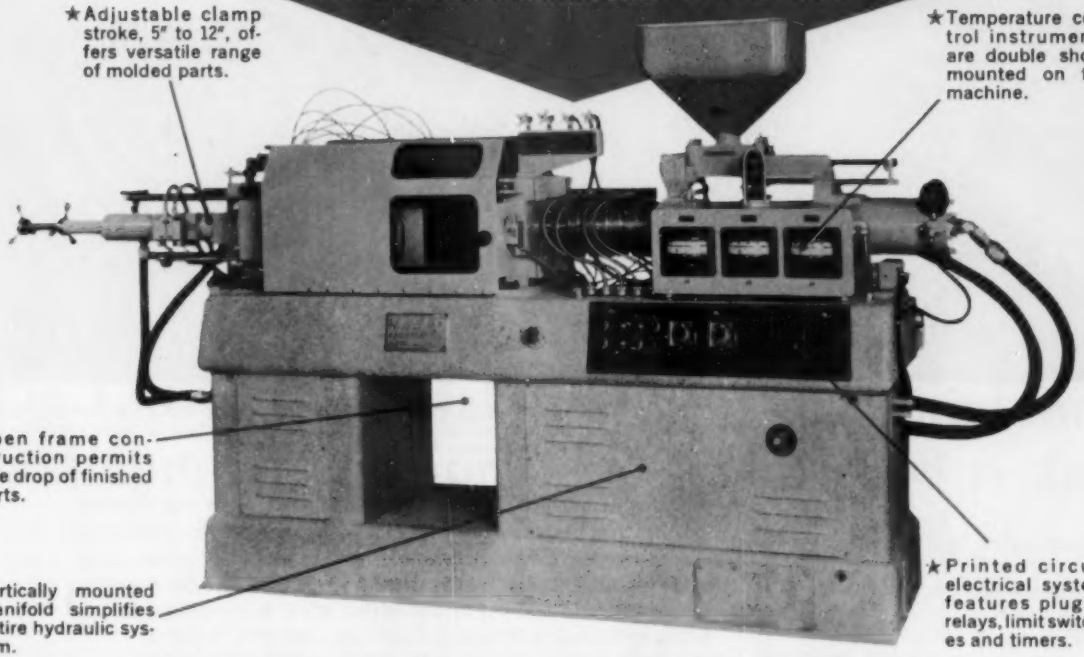

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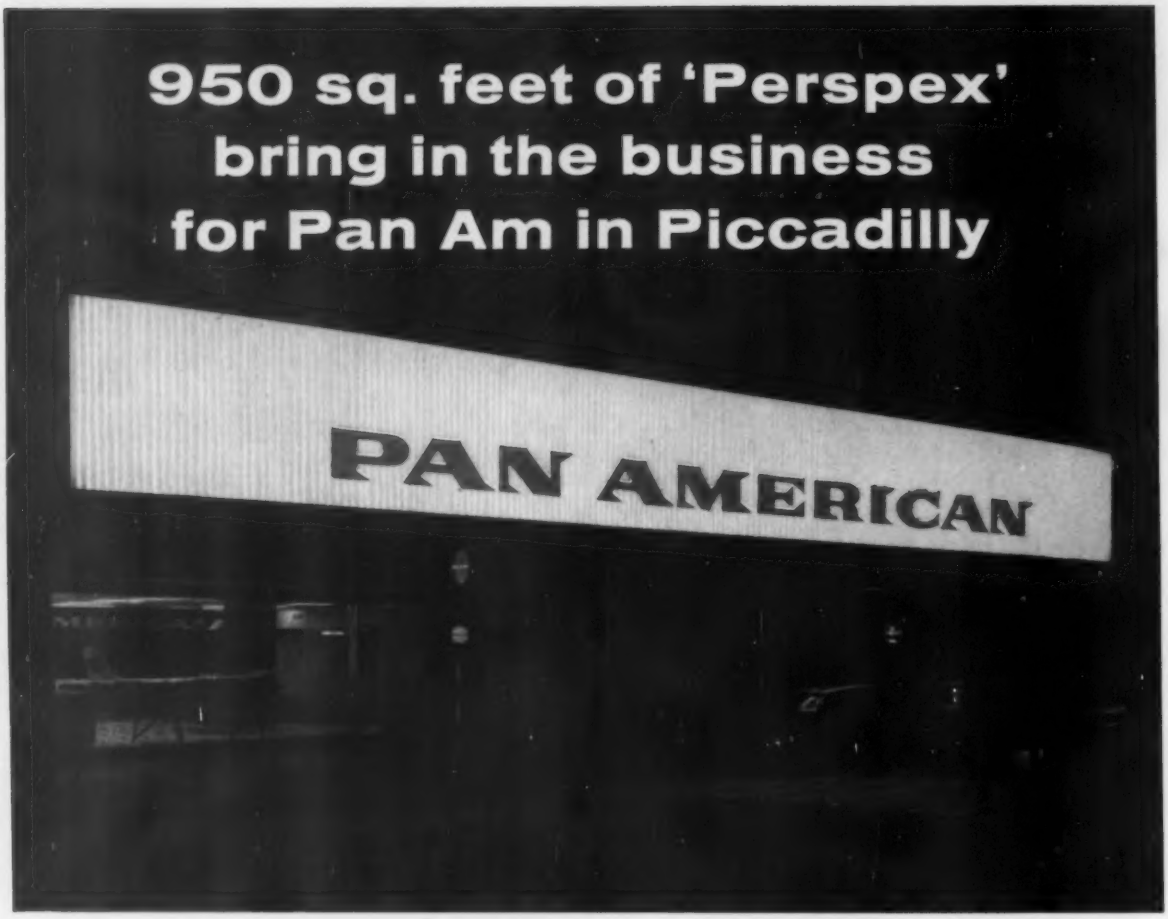

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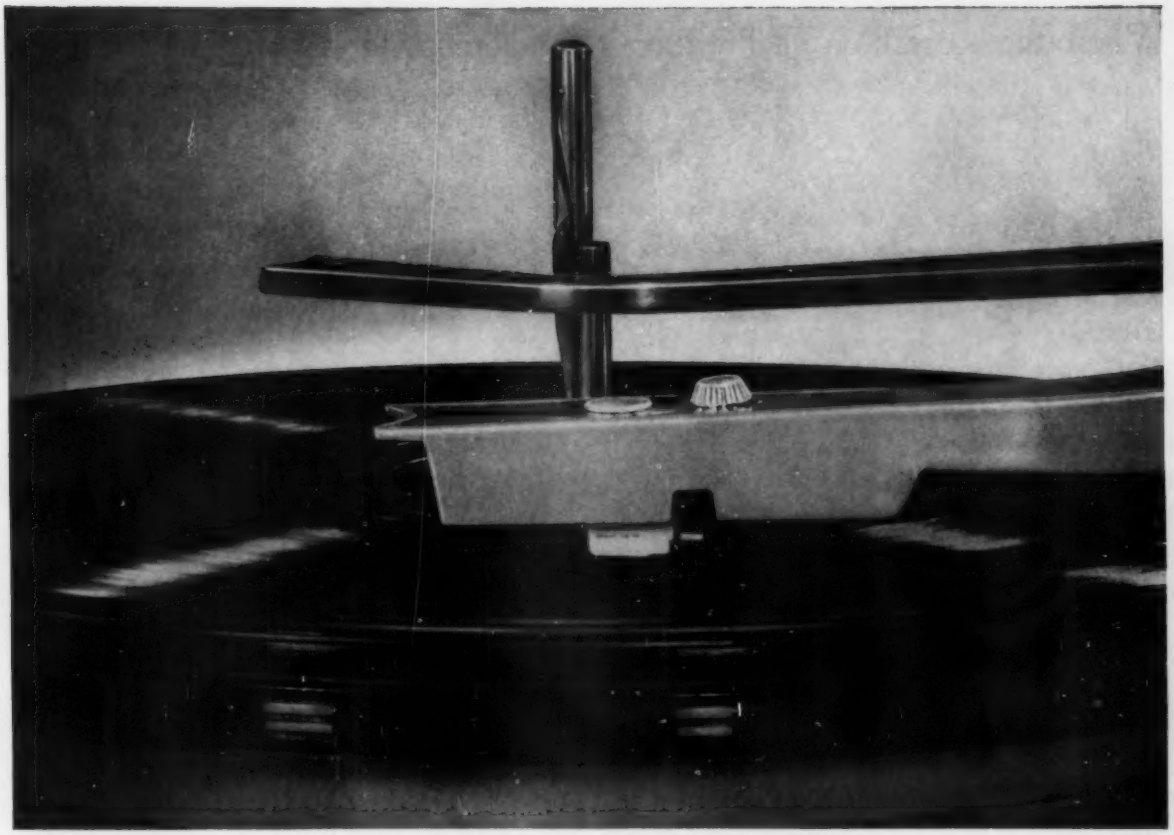

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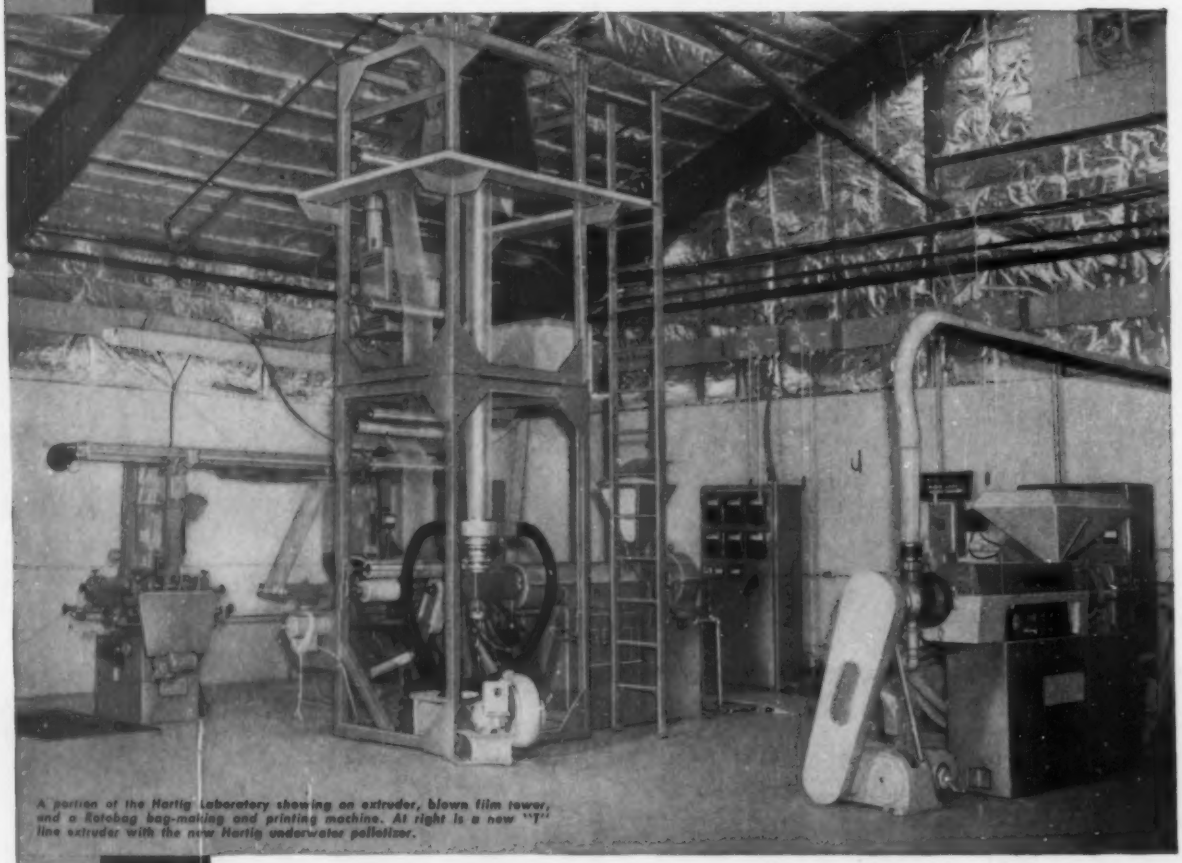

A portion of the Hartig Laboratory showing an extruder, blown film tower, and a Rotobag bag-making and printing machine. At right is a new "7½" line extruder with the new Hartig underwater pelletizer.

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- In all 43 improvements
- Can work on 11 different cycles

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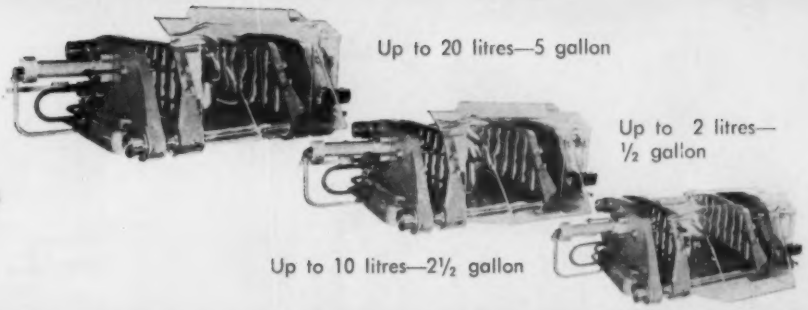
3 TABLES

interchangeable

- Can be changed in 30 minutes



EXTRUDERS

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- Infinitely variable oil drive
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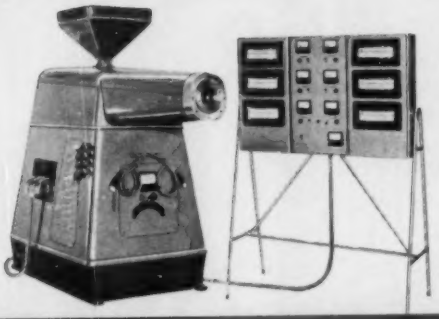
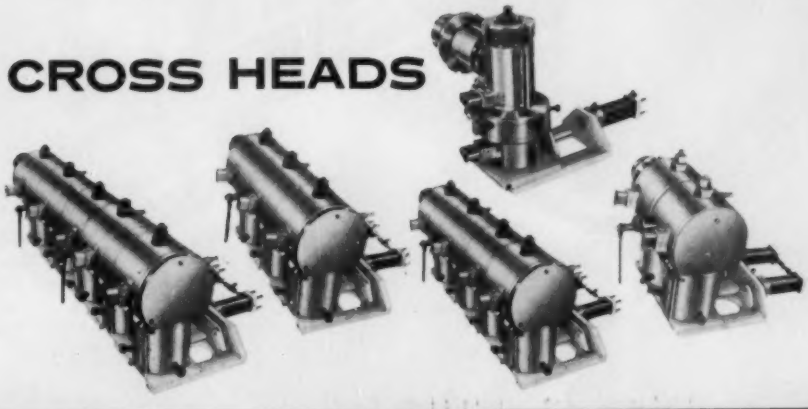


EXTRUDER CROSS HEADS

1-2-3-4-5 zoneheads

- Adjustable wallthickness
- Valves in multiheads allow different lengths of items in the same cycle
- Multicoloured extrusion



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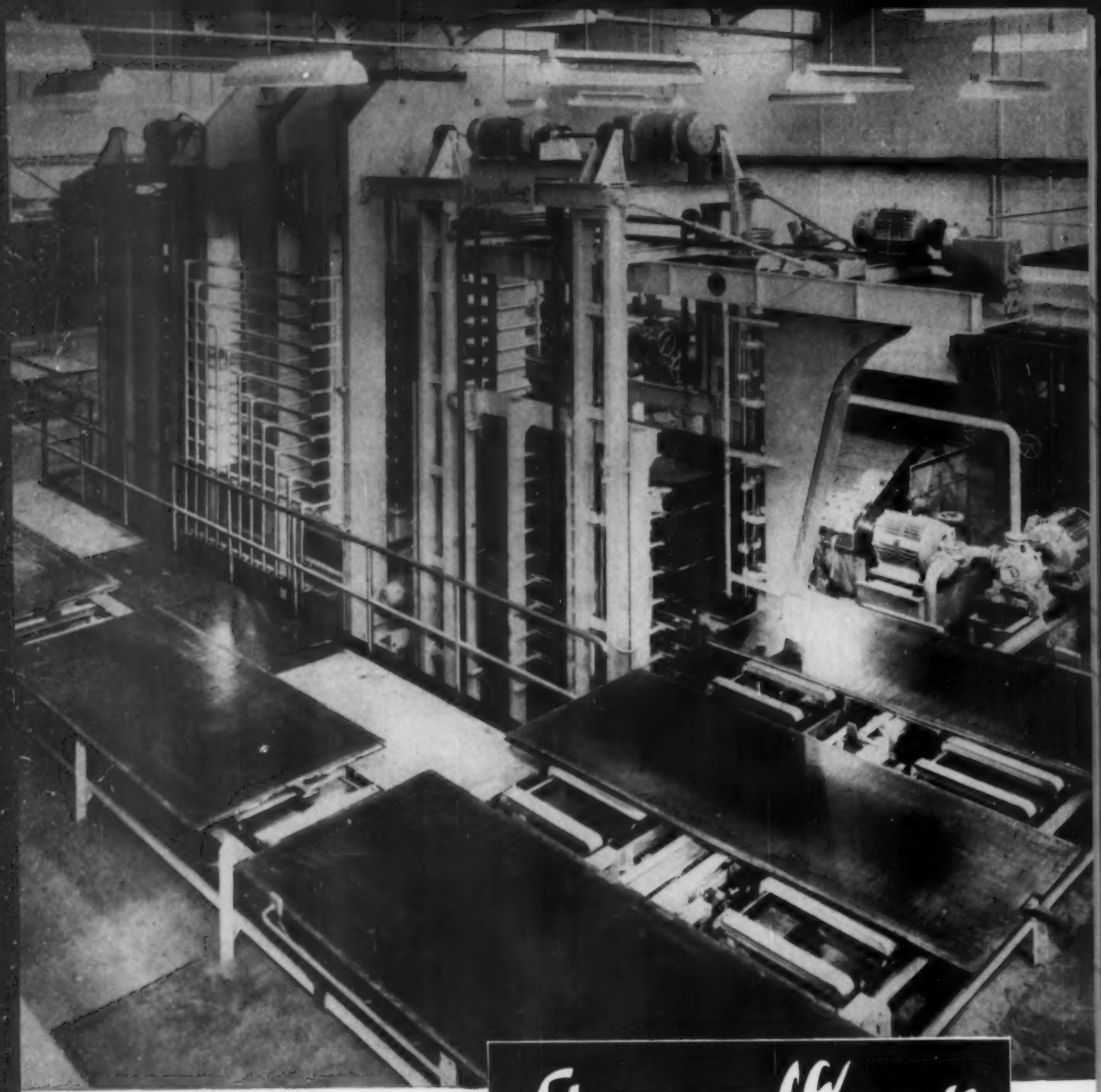

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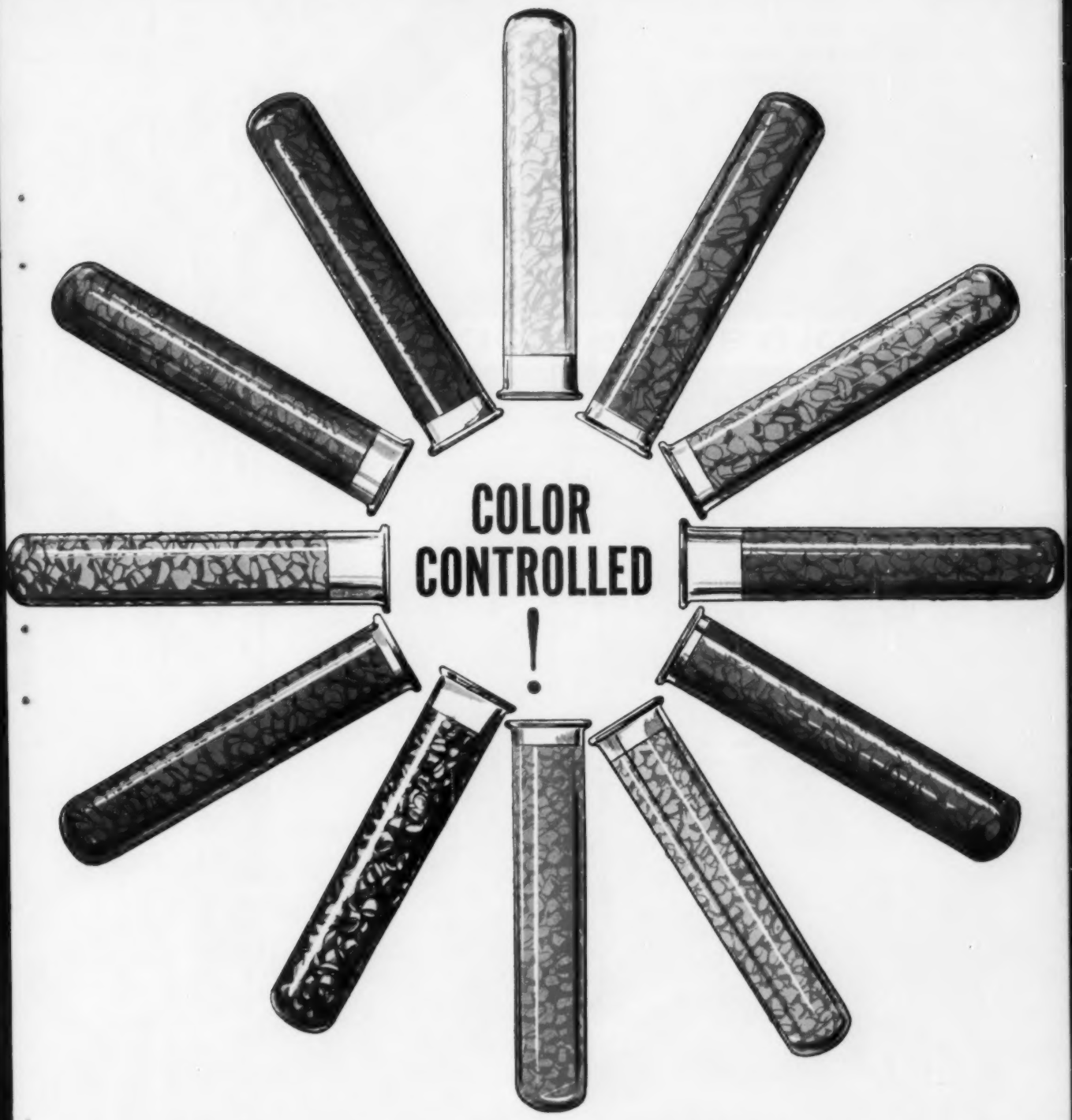

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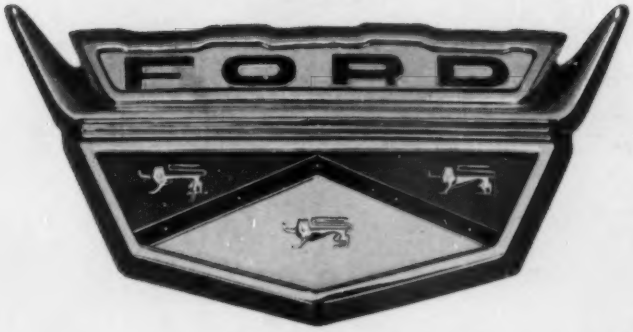

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UVINUL products can be incorporated into UV-sensitive material directly – or can work in a protective shield, wrap, or coating. The table below suggests areas of use. Our chemists can help you apply the UVINUL absorbers effectively – and meanwhile, you can easily test their protective power by using clear cellulose acetate sheets containing UVINUL D-49. Just fill out the coupon and mail it to Antara for your free supply and directions for use.

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Epoxy Resins	XX		X				X
Cellulose Acetate	X		XX				
Latex					XX		XX
Nitrocellulose	X	X				X	XX
Paints, Oil-Base		XX	XX	XX		X	
Paints, Water-Base	X	X	X	XX	XX		
Polyester Resins	XX			X			X
Polyolefin Resins†							
Polystyrene	XX					XX	
Polyvinyl Chloride (PVC)	X		XX			X	
Rubber	XX					XX	
Urea-Formaldehyde Resins							XX
Urethanes		XX	X	XX			
Varnish	XX	XX	X	X		X	

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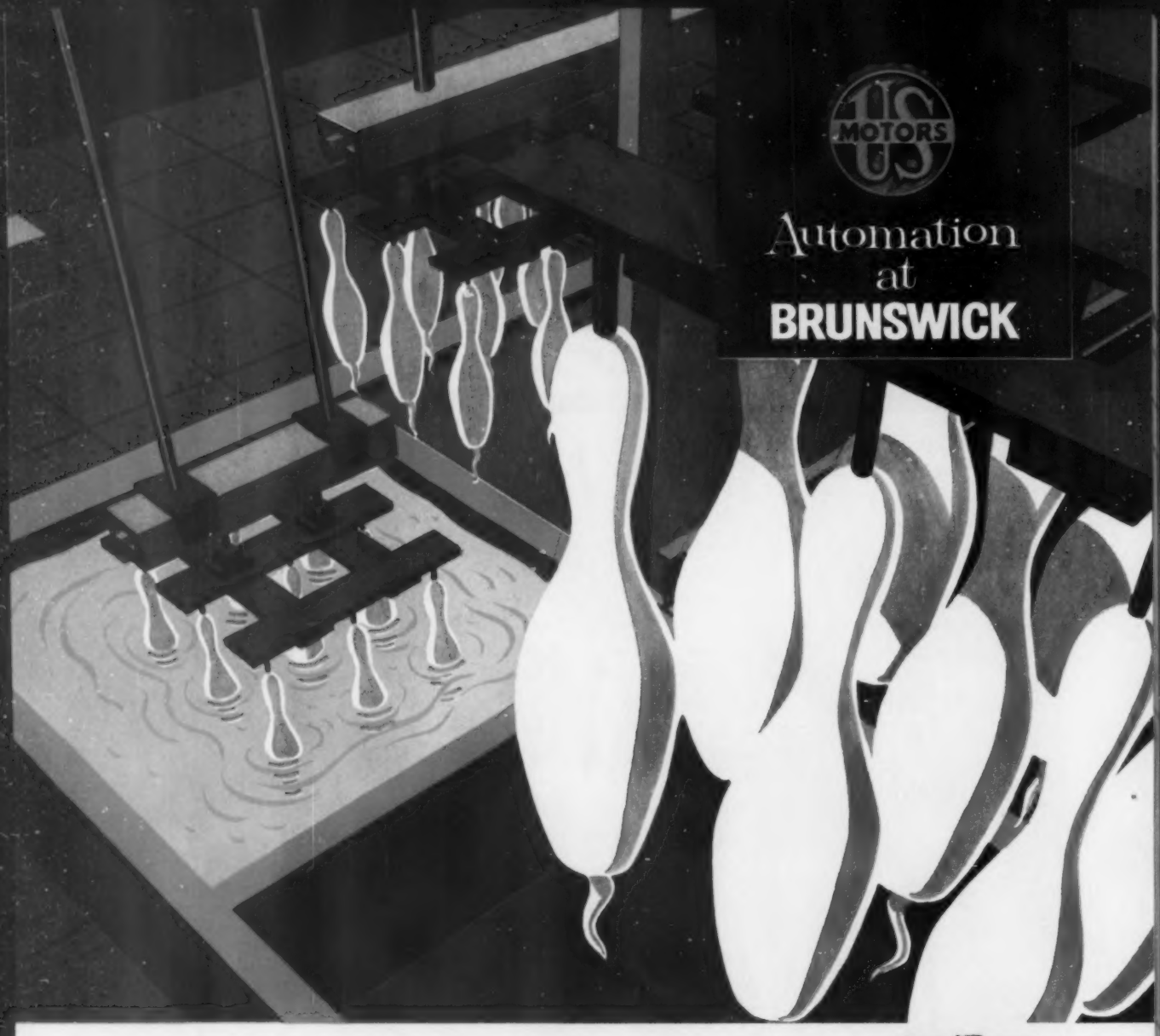

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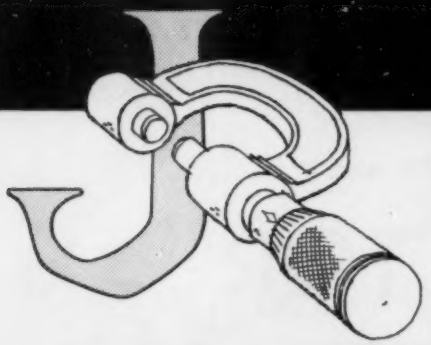

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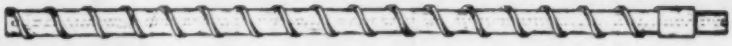

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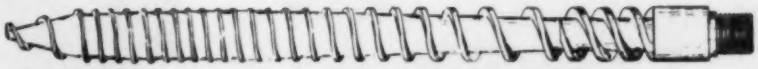

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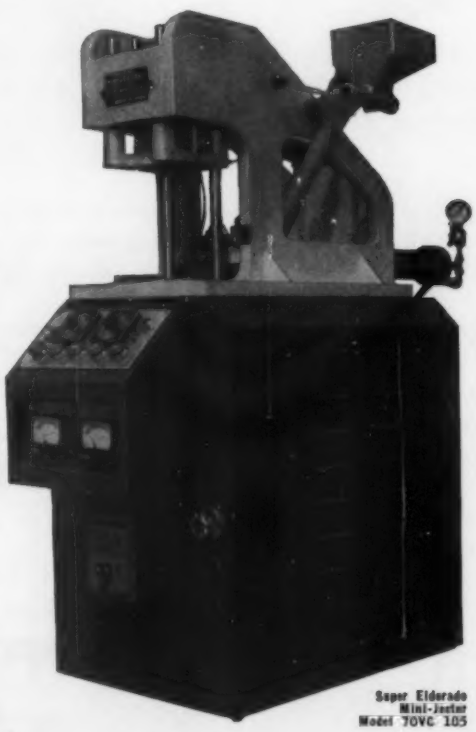

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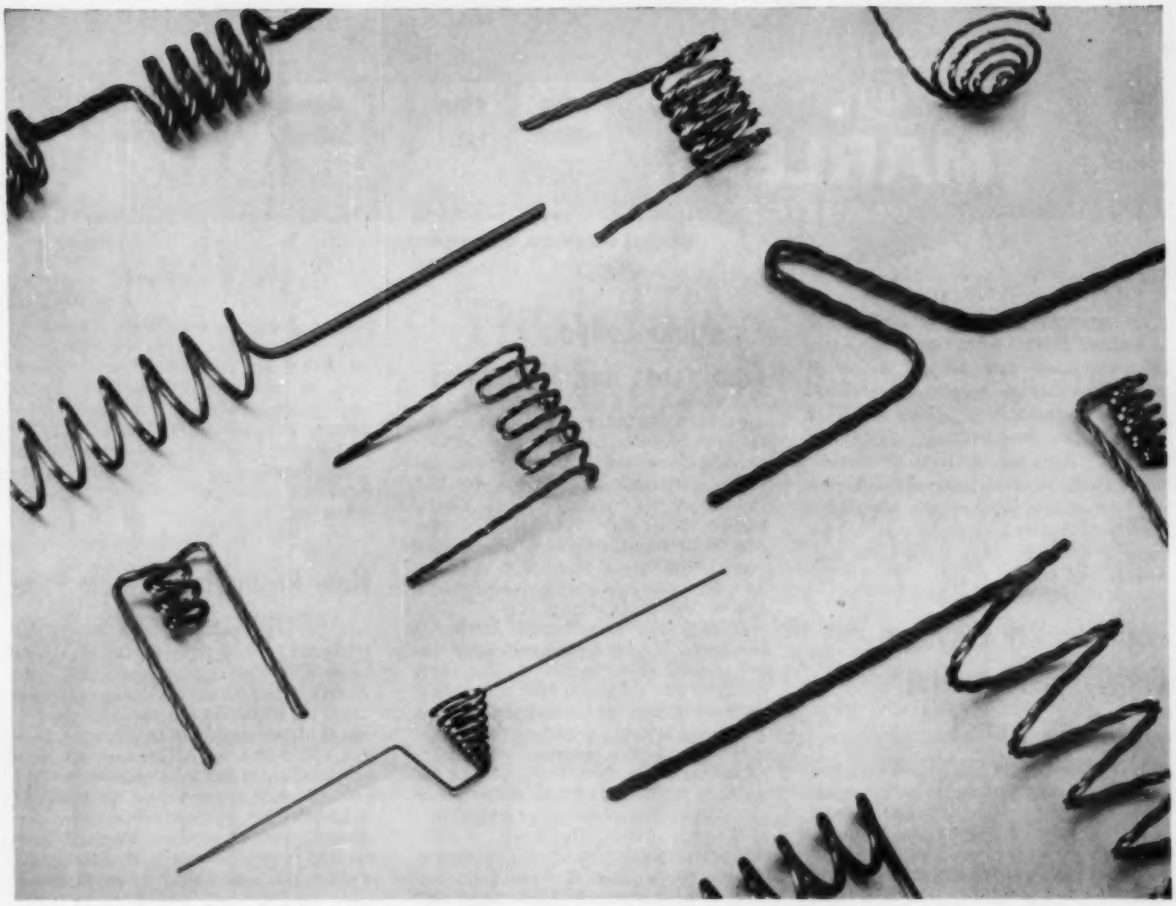

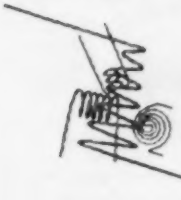

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PHILLIPS 66

MARLEX PLASTICS BRIEFS

SALES SERVICE LABORATORY — REPORT 61-1

Our newsletter, introduced last year to a limited audience, is (we are pleased to announce) now being carried in most plastic trade magazines. Its purpose is to give us lab fellows a chance for a little broadcasting about our work . . . keeping MARLEX customers—and potential customers—up-to-date on new developments, our latest technical reports, and the like. From time to time we may do a little editorializing, too!*

High Density Ethylene Copolymers . . . After Two Busy Years!

Our ethylene-butene copolymers were first made commercially available in September, 1958. Since that time, these MARLEX 5000 resins have been a phenomenal success—especially for blow molding detergent bottles. They are also widely used for injection molding, fibre extrusion, wire and cable coating and non-container blow molding.

In physical appearance, temperature range (–180°F to 250°F), light stability, freedom from color and odor . . . the various melt index types of these new copolymer resins are similar to our original high density polyethylene (MARLEX 6000 resins). The main difference is in density (0.950 for the copolymers and 0.960 for the polyethylenes) and in the superior stress cracking resistance of the copolymers. They gain this desirable attribute at the expense of a nominal loss in tensile strength, rigidity, and resistance to permeation.

Stress cracking is a phenomenon not fully understood . . . although molecular weight, density, and molecular weight distribution are acknowledged as contributing factors. In all probability, the marked increase in both thermal and environmental stress cracking resistance exhibited by these new ethylene copolymers results from an optimum balance between density and molecular weight.

What all this boils down to is a wider choice of high density MARLEX resins. In applications requiring maximum rigidity and resistance to permeation, our 6000 resins are still unbeatable. Where these requirements are not uppermost, the new 5000 resins offer distinct advantages.

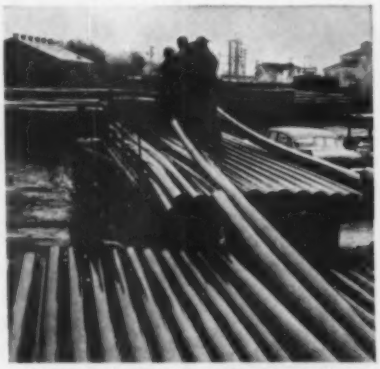
We have just published a new booklet on MARLEX High Density Ethylene Copolymers. It gives the complete story—charts, test data, physical characteristics, etc. If you haven't received a copy, let us know. Ask for Technical Information Bulletin #26.

Pipe and Conduit . . . Comments and New Data

Last year we talked of the potential demand for MARLEX pipe and conduit by utilities, municipalities, and industry (power, telephone, gas, water, and sewage). We have been developing this market for our TR-213 (a high density polyethylene tailored resin) and TR-212 (an ethylene copolymer tailored resin). Millions of pounds of MARLEX have gone into pipe and conduit in the last year—a very encouraging start.

Utilities and municipalities are tough customers . . . and very conscious of cost and overall performance. So far, we're proud to say MARLEX pipe and conduit resins have been enthusiastically received. Word gets around . . . and the lid is off.

How big is the potential market? It's almost hard to imagine. For those who like statistics, we offer some from the American Gas Association covering just a small part of the total market. The A.G.A. sees another 10 million gas customers in the next 10 years, each a user of 2" or smaller secondary distribution pipe. (Let's see, if each customer requires 150 feet of—ah . . . hum!) In addition, A.G.A. calculations of larger diameter primary distribution and gathering lines project some 520 miles per year for the next 10 years.



Rigid 5" MARLEX pipe and conduit like this is now being used for low-pressure gas, oil and water lines, power and telephone conduits, and sewer mains.

Our production department is geared to supply ever-increasing quantities of MARLEX pipe and conduit resin. In addition, we have just published some up-to-date information on pipe and conduit extrusion. This revised Technical Information Bulletin #15 is concerned with the external sizing technique of extruding high density MARLEX pipe. Let us know if you are interested.

New Resin for Coilable Pipe

Another important pipe item! We've just introduced a new high density pipe resin tailored for the coilable merchant pipe market. Pipe extruded from this new resin, called MARLEX TR-414, meets all requirements of Department of Commerce Standard, CS 197-60, for ASTM type III polyethylene, which uses a design hoop stress of 600 psi. It is approved by the National Sanitation Foundation, of course. Incidentally, TR-414 produces the most flexible ASTM type III pipe on the market. As a result, this pipe is ideal for sprinkler systems, potable water systems, farm water lines, and jet wells.

Breakthrough in The Auto Industry

Most manufacturers and material producers who make good in the auto industry manage to boast about it. We're no exception. In the 1961 models we have "scored big". By recent count our MARLEX resins are being used in about ten basic applications—such as seat side shields, side cowl panels, heater and defroster ducts, windshield washer bottles, glove boxes, and spring interleaf silencers. The total estimate for all high density polyethylene in 1961 cars and trucks is figured at close to six million pounds.

"Improved performance at equal or less cost" is almost an auto industry maxim for selecting something new. We feel their increasing use of MARLEX resins is a good testimonial.

*MARLEX is a trademark for Phillips family of olefin polymers.

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MODERN PLASTICS

January 1961 Volume 38, Number 5

EDITORIAL COMMENT

The state of the industries

The plastics industries came through 1960 in surprisingly good shape, production-wise and even sales-wise, with an excess of 6 billion lb. of synthetic resin production and consumption of over 5.5 billion pounds. Final figures for the last three months may move this 5.5 billion point to over the 5.6 billion lb. consumed in 1959. In view of general economic circumstances in 1960, this is a good record.

While sales were well maintained and applications increased in 1960, prices of the three main thermoplastics were driven down to points of diminishing profit. List price of general-purpose vinyl chloride resin is now 18½¢, with deals being made as low as 17 cents. General-purpose polystyrene is being sold as low as 17¼¢, made from monomer that costs at least 11.6 cents. The same trend is apparent in general-purpose polyethylene.

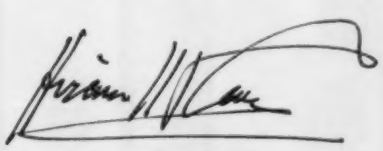
The state of the plastics industries as we enter 1961 is, therefore, one of maintained volume—while steel, aluminum and other materials declined seriously in volume—but a state of low and lower profits because of suicidal pricing.

No one has ever estimated the capacity of the plastics industries, because of their complicated nature. But there is obvious overcapacity. And that, in a dynamic and growing economy, is healthy because it provides standby facilities. But when overcapacity is allowed to dominate the sales scene, pressures on prices and profits become disastrous, leading inevitably to less money being available for development and research.

The main efforts of the plastics industries in 1961, therefore, should accent product research, the development of copolymers and alloys—which will command higher prices—marketing, distribution—and creative salesmanship.

Under-counter deals, slippery contracts, pricing top-grade resins as second-grade to make a sale—these are no part of creative salesmanship. Creative salesmanship is not corrupt.

And may we hope to see better materials offered at justifiably higher prices, which in turn can yield profit sufficient to permit the development of still better materials for bigger markets.



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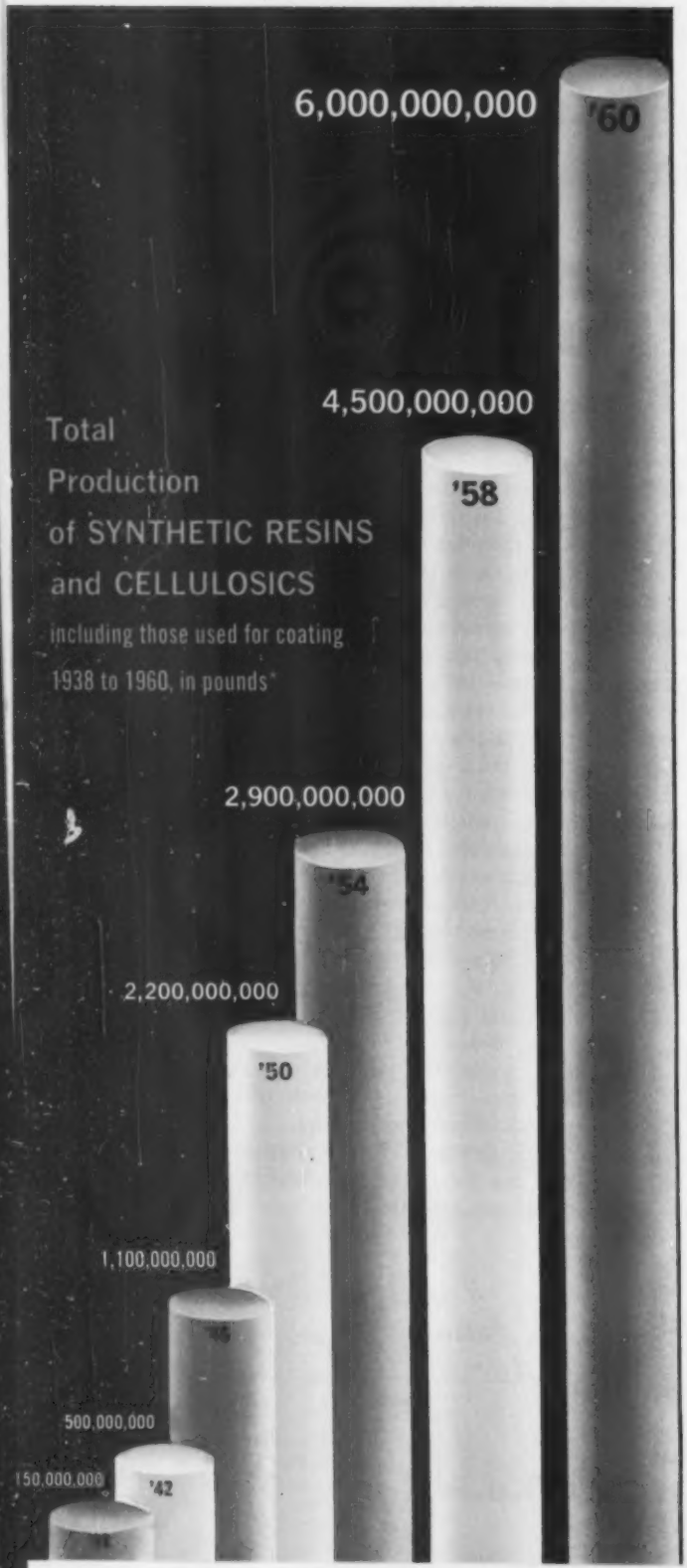
PLASTICS hold to record



The plastics industry was less affected by the so-called "period of adjustment" or economic sluggishness in the 1960 U.S. economy than most other industries. Preliminary estimates indicate that consumption in 1960 was about the same as in 1959 and production may have been somewhat higher due to build up of extensive inventories.

However, although the plastics industry held its own for most of the year, it did not escape entirely unscathed. By the final quarter, the general business recession was taking a toll of sales. Since final figures for these three months were not available when this MODERN PLASTICS report went to press, it is necessary to estimate them; and conflicting reports from sales managers of the various producing companies didn't give a clear picture of whether the overall decline in this final quarter was steep or medium.

In any case, 1960 was at least the second-highest year in terms of resin consumption since plastics first became commercially available. In view of the general economic circumstances prevailing in 1960, plastics rang up a remarkable record.

Total production of all synthetic resins in 1960 was something over 6 billion lb., as shown in the graph on this page. The exact figure depends upon how much inventory of resins was built up in suppliers' plants during the last four months. The 1960 figure is almost the same total as was recorded in 1959 by the Tariff Commission. The official returns will have to wait until the Commission's report, due in March or April.

The MODERN PLASTICS estimate of consumption for 1960, shown on the next page, is over 5.5 billion lb., compared with 5.6 billion in 1959. This difference is so close that it could swing either way when the official returns are all in. The MODERN PLASTICS estimate is always at variance with the Tariff Commission's. This results from the inclusion by MODERN PLASTICS of most of the total alkyd and phenolics production figure within its total consumption figures. The theory is that captive plants (those that make and use their own resin) in the alkyd and phenolics industry do not report what they use themselves as a sale; consequently,

6 billion lb.

the production figure is closer to actual consumption than is the sales figure. The Tariff Commission, on the other hand, reports a big difference between production and consumption because its latter figure is basically equated with the total sales to outside users.

Another approach to the problem would be to completely omit consumption figures for alkyds, rosin esters, and coumarone indene from the total, on the basis that they are not generally considered part of the plastics industry. In this case, the consumption figures of resins and cellulosics used for plastics would be cut to approximately 4.7 billion lb. in 1960 and 4.5 billion in 1959.

Two noticeable activities that created mental disturbance, if not prostration, among plastics producers in 1960 were over-expansion and price cutting. The latter, of course, was probably a corollary of the first. But "over-expansion" is a common ailment of any growing and fairly new industry—and usually indicates great confidence in its future. The recent widespread price-cutting in plastics is but a part of the broader shakedown in the entire chemical industry.

Polyethylene was the only resin to show a sizable increase in 1960, thanks partly to the volume advances made during the year by producers of low-pressure polyethylene. Much of this gain, however, was offset in the first six months of the year when the high-pressure polyethylenes failed to show much growth. As a result, the 1960 rate of growth was far less than the spectacular rates achieved in polyethylene in the past four or five years.

Full discussion on specific materials will be found on the following pages:

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Cellulosics ..... p. 102
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Nylon, acetal, polycarbonates p. 105
Fluorocarbons ..... p. 107
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Consumption in pounds of synthetic resins and cellulosics, including surface coatings, in 1960[a]

Cellulose plastics		
Cellulose acetate and mixed esters		
Continuous sheets under 0.003 gage	18,700,000	
Continuous sheets 0.003 gage and over	20,700,000	
All other sheets, rods, and tubes	10,500,000	
Molding and extrusion materials	93,000,000	
TOTAL		142,900,000
Nitrocellulose sheets, rods, and tubes		1,500,000
Phenolic and other tar-acid resins[b]		
Molding materials	220,000,000	
Laminating resins	90,000,000	
Abrasives	14,500,000	
Friction materials, brake linings	15,500,000	
Plywood	40,000,000	
Thermal insulation binder	52,000,000	
All other bonding resins	70,000,000	
Protective coatings, modified and unmodified	60,000,000	
Miscellaneous	40,000,000	
TOTAL		602,000,000
Urea and melamine resins		
Textile-treating and textile-coating resins	36,500,000	
Paper-treating and paper-coating resins	28,000,000	
Laminating	31,000,000	
Bonding and adhesive resins for plywood	84,000,000	
All other bonding and adhesive uses	31,000,000	
Protective coating resins, straight and modified	26,500,000	
Resins for all other uses, including molding	124,500,000	
TOTAL		361,500,000
Vinyl chloride		880,000,000
Other vinyls including acetate, saran, butyral, etc.		205,000,000
Styrene-type resins		
Molding materials	688,000,000	
Other types, coatings, etc.	234,000,000	
TOTAL		922,000,000
Alkyd and rosin modified coatings except phenolics[b]		600,000,000
Coumarone-indene and petroleum polymer resins		200,000,000
Polyesters		145,000,000
Polyethylene		1,201,000,000
Epoxies		40,000,000
Miscellaneous[c]		250,000,000
GRAND TOTAL		**5,551,900,000**

[a] Source: U. S. Tariff Commission, first 8 months; last 4 months estimated.
[b] Production figures used for all phenolics and alkyds because of large proportion of captive plants.
[c] Includes acrylics, nylon, polypropylene, silicones, polycarbonates, and other miscellaneous.

MARKETS FOR MATERIALS—1960

POLYOLEFINS

Sales of high-pressure polyethylene about level with 1959 . . . Linear PE up over 80 percent . . . Over-capacity and price declines mean only temporary slow-down in growth . . . Blown bottles taking over detergent market . . . Five firms now producing polypropylene; three more to start this year or in 1962 . . . Expected 1961 figures: 100-million-lb. consumption, 300-million-lb. capacity. Rope is now probably largest single end-use, but large moldings like luggage cases and TV parts taking hold.

Polyethylene

The year 1960 was not a bad year volumewise for high-pressure producers—they sold more than a billion lb. of polyethylene. But there was almost no growth. Sales of around 1.060 billion lb. were only about 40 million lb. higher than 1959. This was a bitter pill to swallow for an industry that has been growing at a rate of from 150 to over 250 million lb. each year for the last five years. A tricky and potentially dangerous angle to this situation was an export figure of over 300 million lb., or almost one-third of total consumption. Exports continue to grow, but one day they must decline due to expanding polyethylene facilities in foreign countries. When this happens, that lost market must be absorbed by domestic consumers. Government figures on domestic consumption and export are given in the table on p. 86.

Perhaps the most worrisome feature of this leveling-off situation in consumption is that PE production capacity continues to increase. According to a survey conducted in late 1959 by the Chemical and Rubber Division of the U. S. Business and Defense Services Administration, the capacity of the industry was 1,584,000,000 lb. on Jan. 1 1960, and will be 1,984,000,000 lb. in 1961 and 2,129,000,000 lb. in 1962. Only 355 million lb. of this capacity is listed as linear, or low-pressure, polyethylene. Low-molecular-weight resins of less than 0.910 density (the type used for wax, coating, polishes, etc.) are included in these figures for high-pressure polyethylene but their volume is not sufficient to lessen the gap between sales and capacity to any great extent.

Many reasons are given for the failure of conventional polyethylene to show a greater gain in 1960. The most common one is the general letdown in nearly all business last year. But when there was a general business decline in 1958, polyethylene gained almost 200 million lb. while most other plastics, except polystyrene, showed little or no gain. In those days someone seemed to be finding a new use for polyethylene almost every time the clock ticked. And this is another reason given for the slow-down in 1960: not so many new uses were discovered in 1960 and some of those that had been expected have not yet materialized.

Another reason oft quoted is that there was extreme buying in 1959 for inventory purposes—resin for use in 1960 was bought in 1959. This factor alone disrupted statistical efforts to ascertain the true status of the industry in both '59 and '60. Some measure of this trend is illustrated by the difference between sales and production figures. In 1959 the difference was around 50 to 60 million lb.; in 1960 production ran at least 250 million lb. over sales.

Another angle is that constant rumors of pending price reductions circulated through the industry during the first half of the year. Consequently, buyers who needed resin held off purchases as long as possible.

The break in price that processors had been waiting for came in August when general-purpose and film grade resins dropped to 27½¢ from a previous 32½¢ per pound. Some companies also established a 26¢ price for molding material. This particular grade was reported to be a resin not quite good enough for film, but adequate for molding without stress cracking. It was supposed to be aimed at the volume markets for the so-called sub-standard materials which had reportedly been selling at a range of from 22 to 30¢/pound. This type molding material has low melt indices ranging from 7 to 10. A higher melt index material for large moldings was priced at 27½ cents. Various other resins for quality pipe, electrical grade, weatherable film grade, and flame retardant grade sold in a range varying from 32½ to 43 cents.

The lowered price of resin was almost immediately felt in the film and paper-coating industries, where prices went down a corresponding amount. It was hoped that the reduction would be of some benefit to film producers because of their low-

profit operation but the first reaction instead was a substantial price drop. However, packaging film producers began to revamp their schedules by cutting back some of the discounts. The former price of film, with discounts, was roughly 47¢ per pound. The price for construction and agricultural film seems to bear little relation to resin prices. Prices had been going down since April 1960, but on Oct. 1, went up 15 or 16 percent. This film was once priced higher than packaging film, but has been through the price wringer and is now back at around 41 or 42 cents.

The low-pressure (high-density or linear) producers had a good year in 1960; at least two of them are installing additional facilities. Phillips, the largest producer, will have 100 million lb. capacity by May 1961. Consumption has grown roughly from 55 million lb. in 1958, to 95 million in 1959, and 170 to 180 million in 1960. Capacity is close to 300 million lb., but if the present rate of growth in consumption continues, this capacity won't be close to meeting demand. The industry has maintained its price level of 35¢ for general purpose and 38¢ for blow molding type; these were established in 1959.

The oomph that gave greatest impetus to the use of linear polyethylene in blow molding was the development of a formulation by Hercules in 1959 that was suitable for detergent bottles, with good resistance to environmental stress cracking. Other linear producers followed suit. Consumption increased from 6 to 10 million lb. in 1959 to 40 to 45 million lb. in 1960. There are predictions that it may double that total in 1961. The next step is to move in on the household bleach market. In the meantime, all sorts of bottles and carriers are being developed for other markets.

There are also many other uses for blow-molded linear polyethylene products. Some of these items use off-grade resins or blends that use 60 to 80% of linear polyethylene. Included in this list are closures, an accordion-type heater duct

COMPARISON OF MATERIAL COSTS

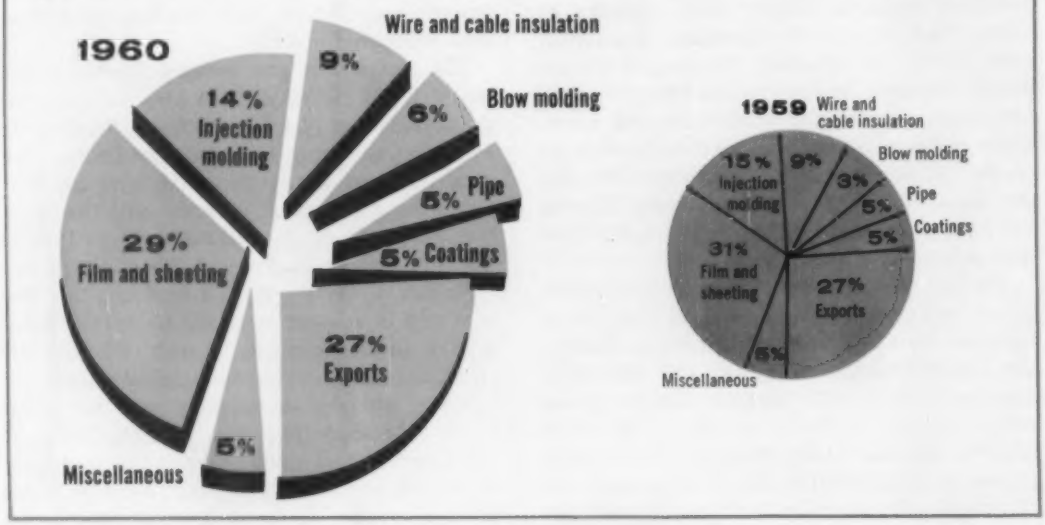
	Specific gravity	*lb./cu. in.*	*Cost* ¢/lb.	*Cost* ¢/cu. in.
Alathon[b] polyethylene	0.914 to 0.96	0.0330 to 0.0346	27.5 to 38	0.91 to 1.31
Delrin[b] acetal[a]	1.425	0.0514	80	4.11
Lucite[b] acrylic	1.19	0.0426	55	2.34
Zytel[b] nylon 101	1.14	0.0412	98	4.04
Zytel[b] nylon 42	1.14	0.0412	108	4.45
Zytel[b] nylon 31	1.09	0.0393	126	4.95
Teflon[b] TFE fluorocarbon	2.14	0.077	360	27.79
Teflon[b] 100 FEP fluorocarbon[a]	2.15	0.078	1160	90.00
Polystyrene, general purpose	1.06	0.0383	19	0.82
Polystyrene, high impact	1.05	0.0379	28.5	1.08
Polypropylene	0.90	0.0325	42	1.36
Modified acrylic	1.12	0.0404	46.5	1.88
ABS resins	1.02 to 1.07	0.0368 to 0.0386	47 to 49	1.80 to 1.81
Polyvinyl chloride, rigid	1.33 to 1.39	0.048 to 0.050	40 to 50	2.00 to 2.40
Cellulose acetate	1.27	0.0458	44	2.02
Cellulose acetate butyrate	1.19	0.0430	62	2.67
Cellulose propionate	1.21	0.0436	62	2.71
Ethyl cellulose	1.10	0.0397	72	2.86
Polycarbonate	1.20	0.0433	130	5.63
Chlorinated polyether	1.4	0.0505	250	12.62
Magnesium AZ-91B	1.81	0.0653	30.78	2.01
Aluminum SAE-309	2.64	0.0953	25.25	2.41
Aluminum SAE-306	2.72	0.0982	24	2.36
Zinc SAE-903	6.6	0.238	16.25	3.87
Brass, yellow	8.5	0.307	23.25	7.14
Brass, 85/5/5/5	8.75	0.316	28.50	9.01
Steel, CR Alloy (Strip and bar)	7.85	0.283	9 to 15	2.55 to 4.24
Steel, Tool: Standard 0.95C	7.82	0.282	33	9.31
Steel, Stainless 304	7.92	0.286	55	15.73

The material costs shown above are believed representative of the pricing on 9/15/60. However, no guarantee as to accuracy can be given. For a detailed comparison, the latest prices should be obtained from the suppliers of the various materials.

[a] Introduced as commercial product Jan. 1960.

[b] Registered trademarks of the Du Pont Co.

Estimated polyethylene consumption by end products



Estimated consumption of polyethylene by end uses[a, b]

End use	*1956* lb.	*1957* lb.	*1958* lb.	*1959* lb.	*1960* lb.
Film and sheeting	160,000,000	205,000,000	245,000,000	335,000,000	348,000,000
Injection molding	50,000,000	80,000,000	120,000,000	175,000,000	180,000,000
Blow molded bottles[c]	15,000,000	20,000,000	28,000,000	30,000,000	65,000,000
Other blow molding				8,000,000	15,000,000
Wire and cable insulation	58,000,000	75,000,000	87,000,000	105,000,000	112,000,000
Pipe and extruded shapes not otherwise classified	35,000,000	50,000,000	55,000,000	55,000,000	57,000,000
Coatings[d]	30,000,000	35,000,000	40,000,000	51,000,000	54,000,000
Exports	125,000,000	190,000,000	242,000,000	305,000,000	320,000,000
Miscellaneous	41,000,000	7,000,000	38,000,000	52,000,000	50,000,000
TOTAL	514,000,000	662,000,000	855,000,000	1,116,000,000	1,201,000,000

[a] These figures do not include reprocessed material that is used in pipe, molding material, black film, or exports, but they do include off-grade resins which are reported by suppliers as virgin material. Some of the off-grade is reported in miscellaneous. [b] Total figures are based on U. S. Tariff Commission reports, except 1960, which is estimated. All other figures are **Modern Plastics** estimates. [c] Includes bottles, jars, tubes, carboys, and toys through 1958. This is a mixed-up figure because low molecular weight polyethylene (wax) has been reported in both this category and in "miscellaneous." The 1959 and 1960 figures in this class are estimated as extrusion-grade coating material only.

for automobiles, various housewares items, the top for a compressed gas cylinder, 50-gal. containers, and others *ad infinitum*. Included in the list in 1960 were about 7 million toy baseball bats that consumed nearly 2 million lb. of resin.

Today there are said to be at least 220 blow-molding operations in the U. S. and Canada. Optimists predict that volume of resin used will be 275 to 300 million lb. by 1965.

The largest use for linear polyethylene at present is injection molding. Estimates for 1965 consumption vary from 65 to 85 million pounds. Reason for the wide variation is that so much of it is off-grade or used in blends. Housewares and toys are the largest consumers of molding material in both blends and virgin material. Housewares that require heat resistance and stiffness in use are nearly all switching over to linear polyethylene.

Pipe made from linear polyethylene is showing rapid growth. Producers are using thin-wall material to compete with thicker-wall low-density polyethylene. One producer expects the pipe market to consume almost 50 million lb. of linear polyethylene by 1965.

Two promising fields where linear is expected to grow are 5- and 6-mil film used for heavy-duty bags and in wire and cable. The industry expects some of the problems involved in the use of the bags to be overcome shortly; this application can add much to the over-all figure of from 15 to 25 million lb. of linear polyethylene film and sheeting

APPLICATION HIGHLIGHTS—1960

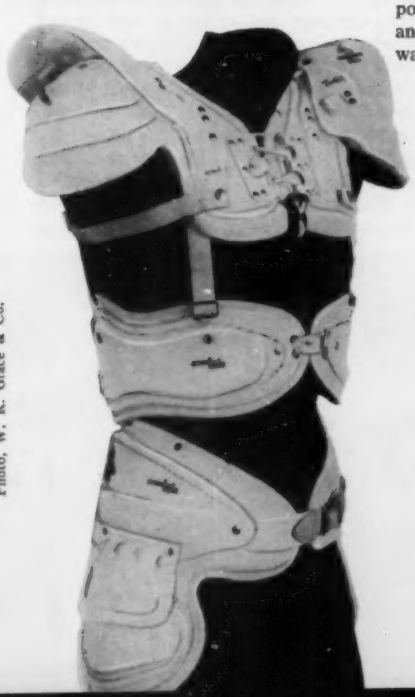
LARGE SIZE and close adherence to tolerances characterize a thermoformed high-density polyethylene cover used to ship missile engines. Sheets used for the two halves of the cover measure 54 by 48 in. and the gage is 0.220 in.—yet tolerances are kept at ±0.030 inch. Thermoforming has now been refined to the point where it can push high-density polyethylene and its many advantages (cover above is 25% lighter than the reinforced plastic it replaced).

Photo, Phillips Chemical Co.

Photo, Spencer Chemical Co.

HUGE 165-GAL. CONTAINER for industrial use is typical of parts made of polyethylene by "thermofusion," a process involving the fusion of powdered thermoplastic inside an inexpensive and easily fabricated sheet metal mold. Advantages: low tooling costs for large parts; extremely economical production of short-run items; production of parts that are relatively stress-free; a wide latitude of design, plus low costs for experimental work. Also on the market: a "thermofused" boat measuring 12 ft. in length!

THE VERSATILE COMBINATION of thermoforming and high-density polyethylene in 1960 is further attested to by a new type of protective football equipment. Replacing fiber parts (at no increase in weight), the formed PE components offer increased impact resistance, more flexibility and comfort, less splitting or cracking, and resistance to water, perspiration, as well as to temperature changes.



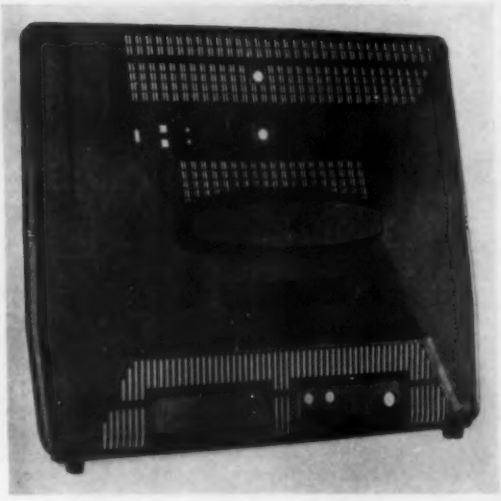
Photo, W. R. Grace & Co.

LARGE JUG-TYPE BLEACH CONTAINERS mark a significant development of blow-molded high-density polyethylene's sweep into big-volume household cleansers and chemicals (liquid detergent bottles are already a major part of 1960 business). Resistance to sodium hypochlorite, lighter weight (a savings of 15 lb. per case of six), and of course, the non-breakability feature highlight the move. An added advantage: moldability that permitted molding-in of large safe-grip handles.

APPLICATION HIGHLIGHTS—1960

←
HIGHSPOT OF POLYPROPYLENE'S advance in 1960 was the introduction by Sears, Roebuck of a line of luggage molded of the material. Five years of development and field testing preceded the introduction of the unusual design in which the shells are molded of polypropylene and also the grid center dividers. Reasons for use: light weight (a 27-in. pullman case is 1½ lb. lighter than comparable models), low cost resulting from mass production, marproof surface, and outstanding impact strength.

Photo, AviSun Corp.



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USE OF POLYPROPYLENE in a molded TV back in 1960 opened a vast new market. High heat resistance, good insulating qualities, and high impact strength highlighted the choice. In addition, moldability enabled the manufacturer to produce an intricately vented backing with cross members less than ¼-in. thick. The set is for a 19-in. Motorola. Maximum use temperature: 290° F.

Photo, Hercules Powder Co. Inc.

↑
ONE OF FIRST U. S. applications of blow-molded polypropylene provides hospitals with an autoclavable combination cup-decanter that weighs up to 66% less than stainless steel and glass, protects better against infections. Unit is needle blown in one piece; top half, or lid, is then cut off and machined so that it can be inserted directly into the pitcher neck. Look forward to aggressive growth in this area—particularly for heat-resistant applications.

↓
CONCEPT OF AN INTEGRAL HINGE (two sections of polypropylene joined by a thin flexible strip) pushed polypropylene into such areas as this automobile air conditioner unit. Using the hinge idea for the movable louvers, manufacturers were able to replace a complex metal assembly with only two molded parts—at a cost saving of more than 65% and a weight saving of more than 90 percent. Other pluses: the assembly cannot work loose with vibration, never requires lubrication, and has a finish that won't corrode. Other 1960 applications for the hinge: automotive accelerator pedals, key cases, containers for contact lenses, hinged cases for such items as portable sewing machines (e.g. Singer Sewing Machine), and others.

Photo, Hercules Powder Co. Inc.

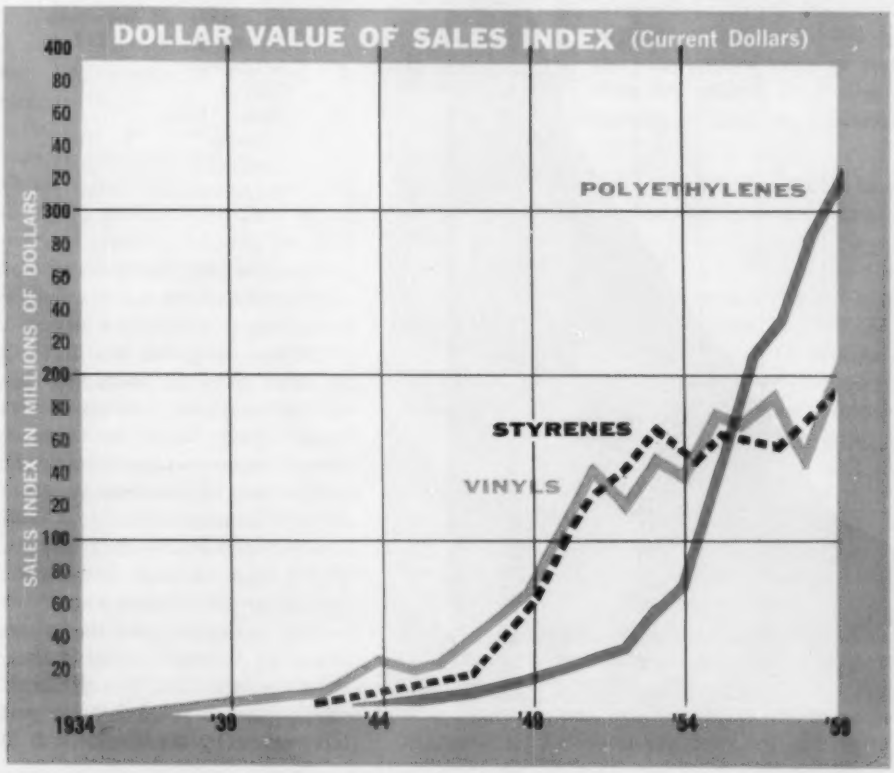
used in 1960. Another possible area of growth for linear polyethylene is vacuum-formed packages from extruded, or possibly calendered, sheeting. The success of this application will depend to a large extent on the development of equipment for forming PE sheet at faster rates.

A phase of the polyethylene industry that is assuming important implications is the wide range of densities—from low to high—now being made commercially available. Nearly all polyethylene producers now carry a line that includes all densities between 0.917 or lower and 0.960. Some of them have to buy either low- or high-density resin from another producer, but deem it necessary so that they may give customers a complete range from which to choose.

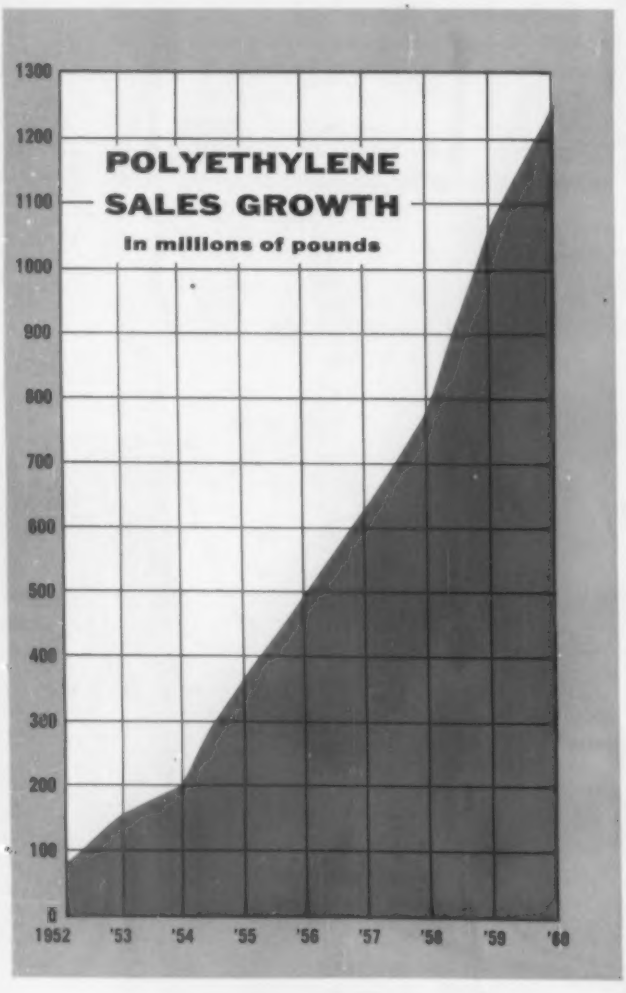
It is becoming increasingly apparent that the term "density" is no longer adequate to describe PE resin. A paper prepared by J. S. Kramer, of Continental Can, on the present and future status of polyolefins has this succinct statement on density: "Density is determined by actually weighing a resin sample and expressing this weight in grams per cubic centimeter. Thus, density is a direct function of the extent of crystalline or amorphous structure in a polyethylene resin. The greater the crystallinity, the more compact and hence the higher the density of the material. Conversely, the greater the amorphous area, the less compact and the lower the density. . . . Today manufacturers utilizing high- and low-pressure polymerization systems are devoting considerable effort toward attaining densities in the middle-range, 0.924 to 0.941. At this time, this is most economically accomplished through a physical mixing of low- and high-pressure process resins."

It is well known by now that higher density gives increased gas and liquid impermeability, stiffness, yield strength, softening temperature, clarity, gloss, and resistance to grease and oil absorption. However, these characteristics are achieved at the cost of decreasing resistance to environmental stress cracking, impact strength, resistance to film brittleness, and tensile strength, according to Mr. Kramer.

The confusing part of this situation is that a high-pressure and a low-pressure resin at the same density have different properties. Yet, there are producers who say that medium-density resins, from 0.926 to 0.945, are likely to take over one-third of the total market in a few years if the trend toward "tailoring for each job" continues. Since



POLYETHYLENE FOR COATING 1960 (lb.)	
Multiwall bags	16,000,000
Locker and freezer paper	2,000,000
Food board (milk cartons)	2,000,000
Foil	8,000,000
Mylar	3,000,000
Cellophane	12,000,000
Sugar pouches, etc.	1,000,000
Miscellaneous	10,000,000
TOTAL	54,000,000



nearly all producers now have a complete line of conventional and linear material to offer, perhaps they will solve the nomenclature problem by abandoning the details and simply identifying each formulation with a symbol. Thus, "this is polyethylene X-12 for film with high clarity" or "this is Y-11 for easy flow in large moldings," etc, will become common usage.

The separation of polyethylene into its various end uses is almost as difficult as trying to read a compass under water at night. For example, the estimates of film consumption vary from 315 to 370 million pounds. One of the reasons is that some estimators count only actual film made by a film producer. But the MODERN PLASTICS estimate includes resin used for film. The waste in packaging film runs from 5 to 8%; in industrial film, from 2 to 3 percent. Some of the waste gets back into the machine and is used in other than packaging film, but there is no accurate check on this situation. Thus, the actual film sold may have been from 320 to 330 million pounds. A majority of film producers think it was close to 330 million. Based on that premise, MODERN PLASTICS offers the following summary of various film uses and reserves the right to change the figures at the least provocation:

Application	*1959*	*1960*
	million lb.	*million lb.*
Packaging	247	258
Agriculture	8	12
Rubber	10	10
Drapes, tablecloths	15	15
Construction	20	25
Miscellaneous	10	10
	310	330

Some of the differences of opinion and comment on the above summary are as follows: Garment bags accounted for around 20 million lb. in 1959 and somewhat less in 1960 (this figure is included under the packaging classification).

Pipe wrapping is in the 4½- or 5-million-lb. class, listed under miscellaneous. Disposable covers, furniture store shrouds, etc., used 5 or 6 million lb., and automotive use (protective upholstery covers) used 3 to 4 million lb. and are also included as miscellaneous. Rolls of film sold in hardware or seed stores are included under agriculture and construction.

It is recognized that the separate items listed above as included under "miscellaneous" total more than the 10 million lb. listed in the table. It should also be noted that the government report represented by the Business & Defense Service

Administration table on page 222 lists domestic distribution of all film at 334 million lb. for 1959, which is considerably higher than the MODERN PLASTICS estimate. But it is not known whether this is actual film or the volume of resin used for film (including trim).

The small increase in volume of resin sold for film in 1960 was a disappointment to the industry since this has nearly always been the area of greatest growth. In the four years preceding 1960, it had shown a growth of 40 to 80 or 90 million lb. annually. The dis- **(To page 166)**

Polypropylene

Productive capacity of polypropylene in 1960, little more than two years after Hercules opened the first American plant at Parlin, N. J. in November 1957, was thought to be between 150 and 200 million lb., depending upon whether or not all the plants supposed to be in the business were able to produce at their announced volume. In addition to Hercules, other present producers are Dow, Texas-Eastman, AviSun, and Humble Oil (whose output is distributed by Enjay and Spencer Chemical). But in 1961 or soon thereafter, capacity will have been increased to well over 300 million lb., as all the suppliers listed above increase facilities and as other suppliers such as Montecatini and Firestone come on stream with announced facilities in 1961. Hercules, the largest producer, will start 1961 with its new 60-million-lb. plant at Lake Charles, La., already in operation. In addition the company has a 60-million-lb. plant available at Parlin, N. J., for making either polypropylene or low-pressure polyethylene.

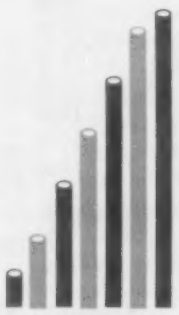
But this isn't all! There are at least six other companies who, up to now at least, have shown definite indications of planning to enter the field, and many others who are said to be contemplating such a project. Shell and Rexall have already announced that they will build plants, but they can hardly be expected to be ready for business in 1961. However, on the basis of all this activity, it is entirely possible that there will be a total production capacity of 500 million lb. in existence in 1965. Any producer of Ziegler low-pressure polyethylene can enter the business by more or less expanding his present facilities and making a few alterations. The petroleum companies have been eyeing the business for a long time; many of them have an interest in propylene, a by-product gas of alkylate gasoline refining. Atlantic Refining is said to be sending out samples.

The fantastic claims for its future potentials made by enthusiastic polypropyleneophiles have aroused management officials and **(To page 172)**

LOW-PRESSURE (linear) POLYETHYLENE CONSUMPTION

Use	1959 million lb.	1960 million lb.	1961 (Est.) million lb.
Injection molding	42	80	115
Blow molding	6	46	95
Pipe and conduit[a]	8	16	24
Film and sheet	3	7	15
Filament	5	3	3
Wire and cable	1	2	3
Paper coating	0	1	1
Export	25	22	20
Miscellaneous	5	6	5
TOTAL	95	183	281

[a] Pipe and conduit includes an indeterminate amount of profile extrusions.



VINYL CHLORIDE

Film, sheeting, and coatings made good increases over 1959. Floor covering grew only slightly, which was big factor in failure of total vinyl industry to show usual increase. Industry will soon have capacity of around 1.4 billion lb. with current sales of less than 800 million. Price drops in 1960 led to complaints of profitless business.

Once upon a time there was a little old lady who put 13 eggs under a setting hen and much to her amazement saw 13 little chicks hatch out. Never before had she seen every egg hatch out. So she pressed her luck. She put 16 eggs under the next setting hen and expected 16 chicks. But the second hen didn't mind her business as efficiently as the first hen; neither could she cover 16 eggs as well as the first hen covered the baker's dozen. She also spent too much time scrounging around off duty. Some of the eggs got cold. Result: 11 chickens.

It may not be fair to accuse the vinyl chloride industry of counting its chickens before they hatched, but that's just about what happened.

Here is the essence of the story:

The industry consumed 874 million lb. of vinyl chloride in 1959, compared with 649 million in 1958—a growth of 225 million pounds. The estimated consumption figure in 1960 will be about the same as 1959—maybe 5 or 10 million lb.

PRICE HISTORY OF

ACETATE

Year	Price $/lb.		
	Group I	Group II	Group III
1948	0.47	0.42	0.33
1949	0.47	0.42	0.35
1950	0.49	0.43	0.37
1951	0.57	0.50	0.42
1952	0.57	0.50	0.42
1953	0.50	0.46	0.42
1954	0.50	0.46	0.42
1955	0.50	0.46	0.36
1956	0.50	0.46	0.36
1957	0.50	0.46	0.38
1958	0.52	0.48	0.40

ABS

Year	Price $/lb.
1954	0.70
1955	0.65
1957	0.58
1960	0.49[c]

[c] Compounded. Straight resin is 45¢.

MELAMINE

Year	Price $/lb.
1947	0.45
1948	0.48
1950	0.45
1956	0.45
1957	0.47

BUTYRATE

Year	Price $/lb.
1938	0.70
1939	0.54
1940	0.49
1944	0.44
1946	0.56
1949	0.51
1950	0.62

METHACRYLATE

Year	Price $/lb.
1937	0.85
1947	0.70
1954	0.68
1955	0.59
1956	0.55

DELRIN

Year	Price $/lb.
1960	0.80

DIALLYL PHTHALATE

Year	Price $/lb.
1956	0.85

MYLAR

Year	Price $/lb.
1951	3.00
1954	2.85
1955	2.50
1956	2.25
1957	2.00
1958	1.80
1960	1.55

EPOXY

Year	Price $/lb.
1953	1.00
1954	1.00
1955	0.80
1956	0.80
1957	0.80
1958	0.62

NYLON

Year	Price $/lb.
1944	1.60
1955	1.435
1956	1.33
1957	1.18
1960	0.98

PENTON

Year	Price $/lb.
1956	6.00
1959	3.50
1960	2.50

PHENOLIC

Year	Price $/lb.
1925	0.60
1931	0.22
1933	0.14
1941	0.155
1943	0.135
1946	0.155
1947	0.165
1948	0.172
1949	0.167
1950	0.197
1954	0.187
1955	0.192
1956	0.202
1957	0.212
1958	0.192
1960	0.21

POLYETHYLENE

Year	L-D Price $/lb.	H-D Price $/lb.
1943	1.00	
1945	0.70	
1946	0.52	
1947	0.47	
1948	0.43	
1950	0.45	
1951	0.48	
1952	0.47	
1953	0.47	
1954	0.41	
1955	0.41	
1956	0.41	
1957	0.35	0.47
1958	0.35	0.43
1959	0.32½	0.35
1960	0.26	0.35

[a] Last figure in column is current price in late 1960. Only years given when price change is made, except phenolic, which skips several years in the late 1920's when prices were declining. Prices are based on lowest quotation for quantity lots. When comparing prices of one plastic with another, reader must consider specific gravity.

POLYPROPYLENE

Year	Price $/lb.
1957	0.65
1958	0.56
1958	0.49
1959	0.42

POLYSTYRENE

(General purpose)

Year	Price $/lb.	Base pounds
1938	0.68	
1939	0.57	
1940	0.52	
1942	0.29	
1944	0.27	
1946	0.26	
1947	0.25	30,000
1948	0.27	30,000
1949	0.255	50,000
1949	0.255	30,000
1950	0.27	30,000
1950	0.305	Any quantity
1951	0.325	Any quantity
1954	0.325	20,000
1954	0.315	40,000
1954	0.305	20,000
1955	0.29	80,000
1956	0.305	80,000
1956	0.275	20,000
1957	0.26	20,000
1957	0.25	20,000
1958	0.2425	20,000
1959	0.215	20,000
1960	0.17-0.18	"

POLYSTYRENE

High impact [b]Natural

Year	Price $/lb.	Base pounds
1949	0.38	50,000
1950	0.395	50,000
1950	0.415	50,000
1952	0.41	50,000
1953	0.37	Any quantity
1953	0.34	Any quantity
1954	0.34	20,000
1954	0.33	20,000
1955	0.315	80,000
1956	0.33	80,000
1956	0.32	20,000
1959	0.31	20,000
1959	0.285	20,000

[b] Offered in color only—through 1952.

POLYVINYL CHLORIDE

Year	Price $/lb.
1934	0.78
1935	0.59
1937	0.56
1940	0.52
1942	0.48
1943	0.44
1944	0.39
1945	0.35
1946	0.33
1948	0.34
1950	0.36
1951	0.38
1954	0.37
1955	0.35
1956	0.32
1957	0.30
1958	0.235
1959	0.235
1960	0.205
1960	0.185

PROPIONATE

Year	Price $/lb.
1956	0.62

SARAN

Year	Price $/lb.	Base pounds
1939	1.25	
1939	0.75	
1940	0.70	
1940	0.59	
1940	0.54	
1941	0.53	
1944	0.45	
1945	0.40	
1947	0.35	30,000
1950	0.39	
1952	0.39	20,000

STYRENE/ACRYLONITRILE

Year	Price $/lb.	Base pounds
1955	0.41	80,000
1957	0.405	80,000

TEFLON TFE

Year	Price $/lb.
1944	15.00
1948	9.00
1949	7.50
1950	5.50
1954	5.10
1955	4.90
1956	4.50
1959	3.65
1960	3.60
(FEP)	11.60

UREA

Year	Price $/lb.
1944	0.22
1947	0.29
1948	0.30
1949	0.31
1950	0.33
1957	0.34
1960	0.32[d]

[d] In quantities of 60,000 lb.; 34¢ in lesser amounts.

VINYL PASTE RESIN

Year	Price $/lb.
1947	0.40
1950	0.37
1950	0.39
1955	0.34
1956	0.30
1958	0.28
1958	0.265
1960	0.240

above or below, depending upon final tabulation of sales in the last three months. If the last three months were as low as is estimated, 1960 will be the first year since the war when vinyl chloride failed to register a growth.

The big growth in 1959 had apparently encouraged a great many resin producers to expand their operations. There are now 20 of them in business. Capacity today is estimated at between 1.1 and 1.2 billion pounds. By the end of 1961, if present plans are fulfilled, it will be close to 1.4 billion. With capacity now in excess of consumption by more than 350 million lb., and with more on the way, the vinyl industry is thus troubled with a severe over-capacity problem—a problem incidentally that seems to be prevalent throughout almost the entire chemical industry. This, together with a persistent "economic sluggishness" in general business, is probably responsible for the series of price cuts that has afflicted the vinyl chloride industry during 1960.

Total volume of resin sold in 1960 was relatively high—much higher than any previous year except 1959—but there had been earlier expectation that it would grow during 1960 by at least 50 to 75 million pounds. Obviously, there comes a time when a commodity, any commodity, cannot be expected to increase each year without occasional adjustment between material supply and demand. Alfred P. Sloan Jr., former president of General Motors, probably phrased this best when he pointed out that "1960 will go down as a good year, but a year of some disappointment because we have not yet learned to live complacently without the glamour of a continuous boom."

Most observers feel that the leveling-off in 1960 is by no means permanent—that vinyl chloride consumption is still destined to reach a volume of 1.4 or 1.5 billion lb. in the late 1960's. However, the interim period may be rough if the confusing price situation is any criterion.

By November of last year the list price for general purpose resin had dropped to 18½¢—and it was still claimed that those who previously had been selling at from ½ to 1½¢ under the list price were continuing to do so, despite the new low listing.

Sometimes these price breaks are charged to the threat from foreign resins. In 1959 the import total of vinyl chloride was around 14 million lb.: 2.7 million from Japan, 9.7 million from Italy, and the remainder in small amounts from other countries. Imports for 1960 followed a similar pattern. This is not a high rate of imports out of a total industry consumption figure of close to 900 million lb.; it would probably be much higher if

APPLICATION HIGHLIGHTS—1960

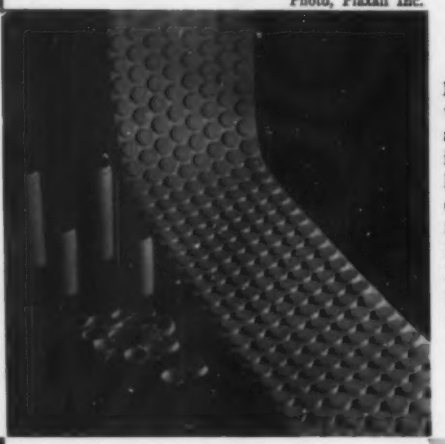
Photo, Navaco Inc.

RIGID VINYL'S invasion of the construction industry in 1960 brought such applications as this unique window awning in which unplasticized PVC slats are bound together by aluminum cross bars on their underside. Reportedly, the tough plastic awning, unlike its metal counterparts, can stand up to all sorts of severe weather conditions without chipping or denting. Among other rigid vinyl applications now being evaluated are complete doors, house siding, and roofing. Already commercial are: vinyl sliding sashes, pipe and conduit, window slides, and frames.

Photo, Consolidated Molded Prods. & Marbon Chemical.

THE FIRST ALL-PLASTIC TYPEWRITER HOUSING highlighted invasion of styrene copolymers and alloys into large-volume, high-quality consumer applications in 1960. Molded in six parts of acrylonitrile-butadiene-styrene (ABS), the housing offers unusual durability, a smooth, glossy finish, attractive integral color, and greater design freedom.

Photo, Plaxall Inc.

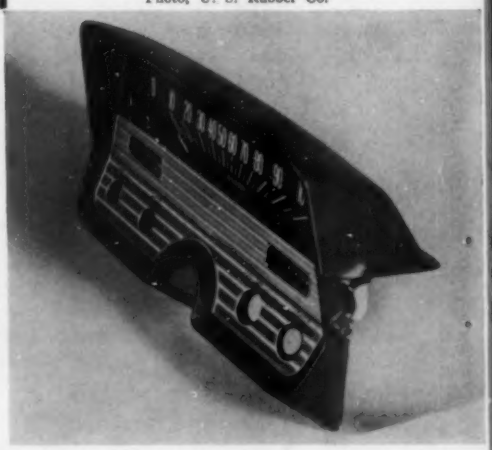


PRESSURE-FORMED non-toxic vinyl bottle caps were produced at a rate of some 1 million a day during 1960. Because of such technological advantages, vinyls, already ensconced in the thermoforming field, should score impressive gains in 1961 in the packaging market. Here the non-toxic characteristics of the unplasticized material should represent an important plus.

Photo, Dow Chemical Co.

A BUICK INSTRUMENT cluster molded in three parts also pointed up the applicability of ABS copolymer for the automotive industry. An 80% weight saving features the swing from die cast zinc to plastic in this application. An unusual feature: a die cut printed circuit bonded directly to the back half of the ABS cluster. Look for the concept to show up in a number of radio, TV, and other type housings in 1961.

Photo, U. S. Rubber Co.



TELEPHONE HANDSET TRANSMITTER CUP for Western Electric is molded of styrene-acrylonitrile copolymer, another of the styrene copolymer materials that gained ground in 1960. Strength of the material permits molding around metal inserts; its chemical resistance helps prevent carbon "poisoning" that causes background static. Other applications of this material: carafe sets, blenders, and water filter bowls.

the American price were up in the 20¢-plus range. On the other side of the fence are American exports of around 40 million lb., most of it in specialty resins that sell at a higher price and are not generally available to world markets from foreign producers.

Of course, it is the price situation rather than the volume of resin consumed that is creating most of the hubbub when industry people get together. The spread between monomer and polymer is getting close. Those who buy monomer are paying around 11¢/lb., and those who make their own charge themselves varying amounts only slightly under this (depending upon their operation costs). But costs for overhead, manufacturing and sales administration continue to increase.

There is little left to invest in resin research and in development of new applications that will broaden the market. In the latter case, it is becoming more difficult each year for resin producers to find new outlets. This alone could prove the most costly of all problems, especially since vinyl has been notable for, and much of its growth based on, entry into new fields almost every year. Furthermore, resin obsolescence is a dark shadow hanging over every resin plant in the country. There are very few formulations today that were in existence seven or eight years ago. If a resin producer doesn't have the capital to invest in research to develop improved resins, he is indeed a poor bet for survival.

The quarterly pattern of resin sales in 1960 was far from consistent. No one was ever sure what to expect next. The first six months' total was good—440 million lb., compared with 420 million lb. in the same 1959 period and 430.5 million lb. in the last half of 1959. Through October 1960, industry consumption by months was in the 70- to 80-million-lb. range, except for July, which closed with 61 million lb. and August, which came in at an amazing 82 million pounds. In fact, the August total astounded almost everyone even more than the 78-million-lb. figure in June, the highest in the first six months. These two months, June and August, both went contrary to industry history, and no one has yet explained this erratic behavior. The guessable reason for the record sales in August (largest since Oct. 1959) was that processors were building resin inventory for anticipated large-volume production in the last four months of the year which didn't materialize.

Looking at the individual end-use markets, one of the chief reasons why sales of vinyl chloride didn't increase in 1960 was a leveling-off in the floor covering market; sales in this area increased

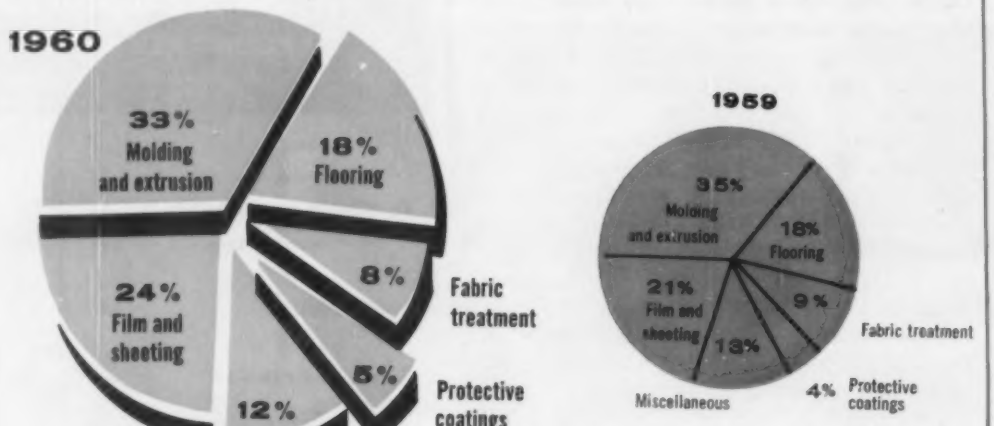
PATTERN OF CONSUMPTION OF CALENDERED VINYL FILM[a]

In millions of pounds

Uses	1953	1959	1960
Draperies, bedspreads, kitchen and bathroom curtains	23	11	11
Yard goods	10	4	4
Adhesive-back film	—	6	9
Closet accessories	6.5	8	8.5
Shower curtains	6	11	11.5
Nursery goods	4	3.9	4
Baby pants, liners	2.4	7	7
Table covers	4	3.5	4.5
Appliance and furniture covers	6	8	9
Rainwear and sportswear	10	7	6
Aprons, including industrial	1.5	2	2.5
Lamination, quilting	—	25	27
Wall covering	—	2.2	2.8
Industrial tape	—	8	9
Inflatables	—	10.5	11
Industrial, agricultural, automotive	20	20	20
TOTAL	93.4	137.1	146.8

[a] This table includes only products made of calendered film up to 10 mils thick. Everything over 10 mils is classified as sheeting. It is impossible to exclude some overlapping items such as inflatables. The figures are intended only as approximations, to show trends. No accurate statistics are available. See text for discussion.

Consumption of polyvinyl chloride and copolymers



Polyvinyl chloride and copolymer resin consumption, 1956-1960[a]

Use	*1956*	*1957*	*1958*	*1959*	*1960*
	lb.	*lb.*	*lb.*	*lb.*	*lb.*
Film under 10 mils	78,000,000	78,000,000	74,000,000	90,000,000	96,000,000
Sheeting 10 mils and over	53,000,000	80,000,000	74,000,000	95,000,000	112,000,000
Fabric treatment[b]	55,000,000	55,000,000	55,000,000	77,000,000	67,000,000
Paper treatment	8,000,000	10,000,000	9,000,000	11,000,000	12,000,000
Floor coverings	66,000,000	82,000,000	116,000,000	155,000,000	160,000,000
Molding and extrusion	205,000,000	220,000,000	224,000,000	306,000,000	285,000,000
Protective coatings	29,000,000	32,000,000	27,000,000	31,000,000	40,000,000
All other uses[c]	74,000,000	78,000,000	70,000,000	109,000,000	108,000,000
TOTAL	568,000,000	635,000,000	649,000,000	874,000,000	880,000,000

[a] Source: U. S. Tariff Commission, with estimated alterations due to more varied breakdown. [b] Resin used for laminates with fabric is included in film and sheeting figures rather than in fabric treatment. [c] Includes approximately 40 million lb. of export, a sizable amount of off-grade material and various other uses not included in other classifications. NOTE: Film and sheeting resins are difficult to separate, but the total of the two as given above is thought to represent a reasonably reliable figure on total amount of resin used for both.

less than 10 million lb. in 1960. By contrast, in both 1959 and 1958 this market had increased its consumption of resin by nearly 40 million pounds. The 15% decline in housing, from 1,531,300 starts in 1959 to 1,300,000 in 1960, is claimed to be the principal reason for the leveling off in flooring purchases.

The reader will note that, even though total flooring sales fell off, the use of vinyl flooring still increased by at least a small amount. Obviously, vinyl is continuing to take over a larger part of the total conventional flooring market each year.

Remarkable gains have been made in the plastisol type of floor covering over the past three or four years. This is the type of covering where a plastisol coating is applied to a treated paper, covered with a protective vinyl film, and then applied to a felt base. As much as 18 million lb. of plastisol was probably used for this purpose in 1959. In 1960, the total may have gone up to 24 million. It could go up to 50 million in five more years. A few years ago Sandura was the only company in this business. They have been joined by at least three other large manufacturers of floor covering in the past two years. Furthermore, this type flooring was only slightly affected by the 1960 decline in home building, since the great bulk of its annual sales are primarily as a replacement material for worn out linoleum or other floor coverings.

Another contributing factor to growth of plastisol flooring is the fact that the protective covering was increased from a 4-mil thickness to 15 mils in some of the newer styles. The versatile plastisol floor coverings are also adaptable to a wide range of eye-appealing styles. And new develop-

ments in the industry have made it possible to use the old linoleum machines. By use of low-temperature plastisols, processing temperatures have been lowered to 300° F. from previous levels of 350 to 370° F.

Vinyl asbestos tile is also growing and still has lots more room to expand. Most of the resin used in this application is primarily vinyl chloride-acetate copolymer. Something like 80 million lb. of resin is the estimated total used in this type of flooring. Total vinyl-asbestos floor tile production in 1960 is estimated to have reached 500 to 600 billion sq. feet.

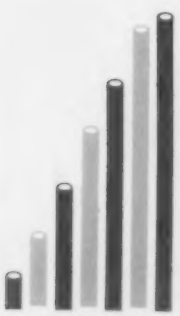
An important event in 1960, indicative of the industry's growth, was the opening of a fourth plant by Johns-Manville for production of vinyl asbestos and asphalt floor tile. This plant increased the company's capacity by 50%--another step in a program that started back in 1947, when the company began the marketing of vinyl-asbestos floor tile **(To page 177)**

VINYL CHLORIDE FOR MOLDING AND EXTRUSION

Application	1959 lb.	1960 lb.
Phonograph records	45,000,000	45,000,000
Slush and elastomeric molding	56,000,000	58,000,000
Profiles	50,000,000	46,000,000
Wire coating	105,000,000	90,000,000
Rigid pipe and shapes	20,000,000	25,000,000
Garden hose[a]	18,000,000	14,000,000
Foam and sponge	4,000,000	4,000,000
Miscellaneous	7,000,000	3,000,000
TOTAL	**305,000,000**	**285,000,000**

[a] A large portion of garden hose is produced from off-grade resin. It is reported here as virgin resin—although it is generally sold to compounders and reported to the Tariff Commission as "all other resins." There is also a good quantity of scrap resin used in garden hose, but that material is not reported in this table.

POLYSTYRENE



Sales in 1960 were not far off from 1959. Drop in refrigeration industry accounted for most of decline, but packaging uses and appliance housings continue to show increasing growth. Consumption of styrene copolymers was moving more rapidly. Price reduction at end of year created some concern and disturbance in the industry.

During the past three years the polystyrene industry has been galloping along at a faster pace than any other plastic except polyethylene. Sales have increased from around 400 million lb. in 1956 to approximately 700 million lb. in both 1959 and again in 1960.

Industry officials can't put their finger on the reason behind the spurt in sales. It may have been the development of improved impact materials and their volume adoption by the refrigeration industry; some believe it was the price reductions of general-purpose resins down from 29¢/lb. in 1955 to a recent low of 18¢; others believe that the impulse came in part from the narrowing of the price gaps between crystal and colored material and between general-purpose and impact types.

A good over-all reason for the growth is that polystyrene has proven itself a satisfactory and useful product. Constant improvements in formulations have provided greater ease of molding, more strength, better light stability, and more heat resistance. It molds as easily as any resin in the business. Its brilliant color range is probably unsurpassed by any other plastic. And it is the lowest-cost plastic on the market.

Until the price break in late November 1960, the 21½¢ price had held firm since early 1959. There were reportedly many deviations or "deals" that cut prices lower, but in general the 21½¢ price was regarded as fairly stable. When the price sniping became more prevalent, however, and as demand tapered off in the last half of the year, capacity to produce was increased. The inevitable happened—down went the gate.

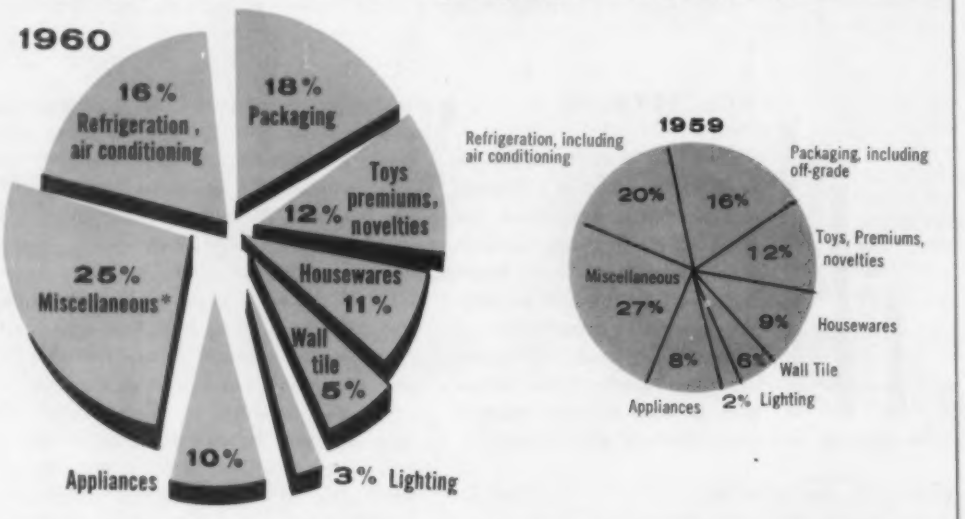
The remarkable success of polystyrene in the last 4 or 5 years has led to a large-scale expansion program. All the major producers have enlarged or added to their facilities in the last two years and many new ones have entered the field. There are now 20 in the business. Five years ago there were only four. (See p. 212, Oct. 1960, MPI, for the list.) Many of the new plants were built by molders or groups of molders who decided to make resin for their own use. But they nearly always have more than enough to supply their own needs and their surplus is thrown on the market. Total volume capacity for the industry is not available but it must be well over one billion lb. and substantial increases are on the way with new facilities coming on stream. With monomer

currently selling at approximately 12¢ and polymer at 18¢, it is a little difficult to understand what is left for profit. Monomer, too, is in great excess capacity, with a slight price drop scheduled for next July when the rubber company contracts are renewed. The cut in price, however, won't be enough to make much difference to the polymer producers who have to buy it. There is, of course, a premium price for colored, impact, and specialty resins, but these cost more to produce. There is already some question as to whether or not there is more profit in these than in general-purpose crystal material.

Bulk handling of resin from shipper to user is another way of paying a lower price for resin. There are several systems in vogue. The latest, for handling polystyrene, is General American Transportation Corporation's Dry-Flo railway car with a capacity of 140,000 pounds. It is similar to the Airslide car for handling PVC. The Dry-Flo car is divided into individual compartments, each coated on the inside with an epoxy resin to prevent contamination of the contents. Auxiliary equipment needed for handling the material from such a car consists of a pump and storage silo for each material. These cost the user from $10,000 to $30,000—a figure that should be amortized in 1 or 2 years. A volume use of 150,000 lb. a month of any one material is considered to be the minimum practical quantity for this system—below that, savings will be negligible.

Impact polystyrene handled in this manner is about 1¼¢/lb. cheaper than that shipped in bags; general-purpose is about ¾¢ less. Truck ship-

Molded and extruded polystyrene products



Styrene type resin sales, 1956-1960[a]

Use	*1956*	*1957*	*1958*	*1959*	*1960*
	lb.	*lb.*	*lb.*	*lb.*	*lb.*
Molding and extrusion materials[b]	402,000,000	429,000,000	476,000,000	700,000,000	
General purpose					278,000,000
Other molding materials					290,000,000
Export					120,000,000
Protective coatings for paint and paper	93,000,000	85,000,000	104,000,000	119,000,000	119,000,000
Resins for other uses[c]	108,000,000	133,000,000	144,000,000	100,000,000	115,000,000
TOTAL	603,000,000	647,000,000	724,000,000	919,000,000	922,000,000

[a] Source: U. S. Tariff Commission, except 1960, which is estimated. [b] Includes plasticizers, fillers, and extenders, modified and copolymer molding or extrusion materials, and more than 40 million lb. which is unreported in the Tariff Commission's monthly reports for 1960, since some companies report only on an annual basis. Also, exports are reported in "resins for other uses" in the Tariff Commission reports for 1959 and 1960, but only partially so in earlier years. [c] Includes foam, high-styrene butadiene rubber reinforcing resins, ion exchange resins, polystyrene used in floor coverings, metal-treating resins, and probably some off-grade resins.

ments in bulk run only about ¼¢ less. There were 18 cars handling this type of shipment in 1959. Dow alone now has 55 cars at work.

The statistical table on page 98 indicates that styrene-type molding materials were down slightly in 1960, but it was still the second best year ever. Total for all kinds of styrene plastics, including coatings and resin for foam, was slightly higher than 1959, but hasn't yet quite reached the 1-billion-lb. mark. Figures for the last four months of 1960 have been estimated—but the market situation was so uncertain when this survey was made that the totals may be 10 or 15 million lb. off when the final count becomes available. The export total is also estimated and is reported in the "molding materials" column. In the Tariff Commission's report it is included in "resins for other uses."

The government's styrene-type resins chart has been well scrambled over the years because company reports to the government have varied in their breakdowns. The export figure was always reported in "molding materials" in the years before 1958 and only partially in that year. The changes in the government figure for "other resins" shown in 1959 and 1960 is due to probable reporting of considerable amounts of off-grade resins in this category in previous years; most of these are now listed under "molding materials." Thus, the total amount of "molding material" reported for previous years was less than actually used and throws out of kilter—although not to a serious degree—a direct comparison between 1959 and 1960. However, in a broad sense the figures are felt to indicate industry trends.

Despite the leveling off in sales in 1960, attributable in large part to a decline in consumption on the part of large customers such as refrigerator manufacturers, there is little pessimism in the industry. (There are, of course, occasional gripes about "too much capacity.") Rather, the industry is becoming increasingly diverse, with lusty entries in the foam and film field, a healthy growth in packaging, expanding use for appliance housings and lighting fixtures and a general "holding its own" in most other applications.

Even if polystyrene fails to grow in 1961 be-

MISCELLANEOUS POLYSTYRENE PRODUCTS[a]

- Lighting fixtures
- Toiletries
- Monofilaments for brushes
- Molded furniture drawers
- Office equipment
- Seasonal decorations (Christmas ornaments)
- Pipe and fittings
- Soil pipe
- Photo equipment
- Dental plates
- Baby equipment
- Window shades (pulls and Venetian blinds)
- Clothes pins
- Recording tape spools
- Sun glasses
- Bar supplies and stirrers
- Toilet seats
- Vacuum cleaners
- Fishing equipment
- Film for packaging and laminating
- Sheet for packaging, lighting, signs, etc.
- Phonograph records

[a] Breakdown by products of percentage shown in chart on facing page.

GROWTH OF FILM PACKAGING MARKET

One producer's estimate, millions of pounds

	1958	1959	1960	1961	1962	1963	1964	1965
Cellophane	415	425	441	454	465	477	487	495
Polyolefins[a]	183	230	274	342	374	429	494	540
Pliofilm	19	23	25	27	29	31	32	34
Vinyl	10	12	15	17	19	21	23	25
Polyvinyl chloride	14	15	17	19	20	21	23	25
Mylar	1	1	2	3	4	6	8	10
Cellulose acetate	5	5	5	5	5	5	6	6
Total	647	711	779	867	916	990	1073	1135

[a] Includes HDPE, LDPE, and polypropylene. By 1965 it is estimated that 20 to 25% of the market will be in HDPE and polypropylene. NOTE: The above figures do not include extrusion coating markets or household wrap markets.

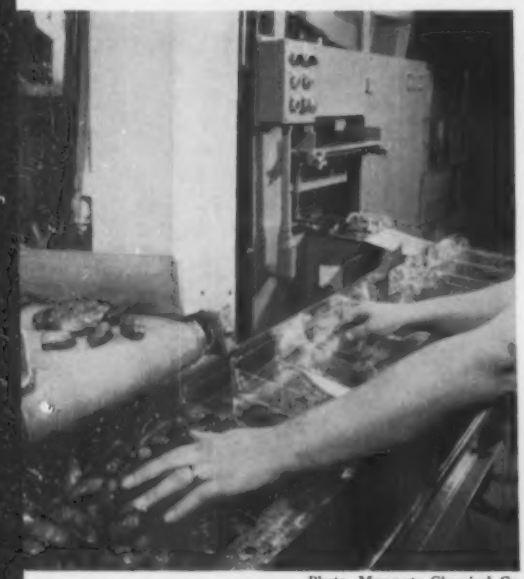
APPLICATION HIGHLIGHTS—1960

Photo, Armstrong Cork Co. Inc.

↑ **EXPANDABLE STYRENE BEADS** can also be extruded into a flexible sheet that can be used as above to protectively wrap a carton containing a fragile product. New in 1960, film and sheet of this type have already shown up in insulated bags and other containers, as cushioning slip-sheets, in novelties and toys, and when laminated to paper as an insulated, low-cost disposable coffee cup. Watch for more in 1961.

↓ **MEASURING 9 FT., 3 IN. BY 8 FT., 6 IN.,** insulated door for refrigerator railroad cars emphasizes the extent to which beads became an important segment of the polystyrene market in 1960. Door is made by expanding the polystyrene beads directly into a shell vacuum formed of acrylonitrile-butadiene-styrene copolymer sheet. The 89-lb. foam molding forms a light, moistureproof, nonsagging insulation which saves some 400 to 500 lb. in weight.

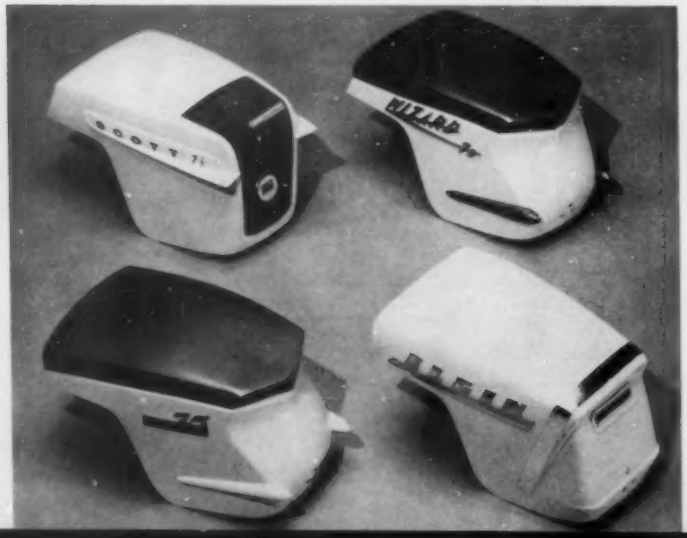
Photo, Koppers Co. Inc.



Photo, Monsanto Chemical Co.

← **TYPIFYING REFINED TECHNOLOGY** that is pushing styrene into a number of new applications is a rigid oriented styrene tray for dates that is processed on a fully automatic packaging system which does not require the use of heat or adhesives. The manufacturer simply combined conventional paperboard filling and wrapping equipment with a new tray-folding machine which cold forms and locks die-cut oriented styrene film into trays.

Photo, Rohm & Haas Co.



→ **HIGH-IMPACT** acrylic molding powder began to live up to its expected potential in 1960 with such applications as these outboard motor housings. Tough, weather-resistant, immune to corrosion, and adaptable to mass production by injection molding, the housings may be the start of many similar units for business machines and smaller home appliances.

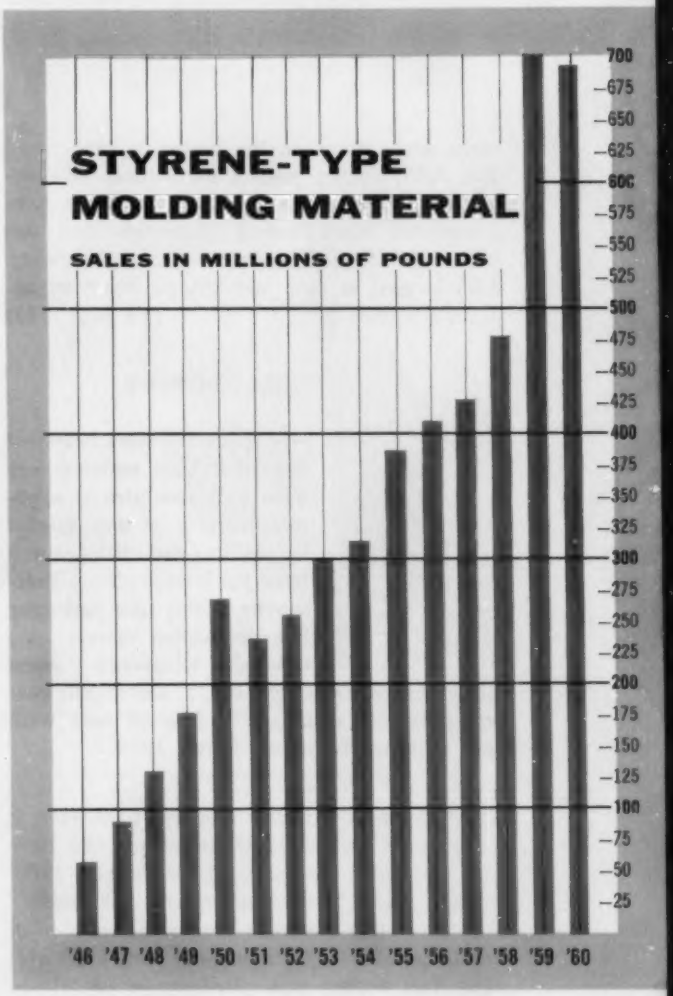
cause of general sluggishness in all business, there should be little despondency in the polystyrene business since its roots now seem firmly established in the overall U. S. economy. If growth is slowed, or halted, it will pick up again just as soon as the predicted golden 1960's begin to show their glitter. There are, of course, those who think the future isn't bright from a profit viewpoint, but declining prices and small profit rates in large-volume operations are nothing unusual in the history of American enterprise.

The combined figure of general-purpose and other styrene-type molding material, exclusive of exports in the table on page 98, is a little over 600 million lb. in 1959 and a little over 570 million lb. in 1960. General-purpose was estimated at about 285 million lb. in 1959 and 280 million lb. in 1960; impact styrene at around 250 and 220 million lb.; copolymers at 60 million lb. in 1959 and 70 million lb. in 1960. The copolymer figure is the least predictable of all, but there is a general feeling that it increased in 1960 and was larger in 1959 than generally estimated.

Interest in copolymers is keener at the moment than it has been for several years. Foster Grant with acrylonitrile-styrene (ANS) and B. F. Goodrich Chemical, now producing acrylonitrile-butadiene-styrene (ABS), have been added to the list of producers, and Monsanto is expected to produce both at its expanded facilities in Ohio.

ANS is a clear, highly chemically resistant material with a higher impact than general-purpose polystyrene. ABS is a notably tough, hard material with good chemical resistance but is *not* transparent. The tradenames for ANS are C-11 by Union Carbide, Tyril by Dow, and Fostacryl by Foster Grant. ABS is produced by Marbon under the name of Cycolac and by Naugatuck Chemical under the name of Kralastic. The Goodrich trademark is Abson. Prices of ANS are 40½¢/lb.; prices for resin and compound in ABS run through the 40's and low 50's.

The ANS material has been around for a long time without much growth—and now runs may be 20 to 25 million lb. a year. But there is an unusual undercurrent of feeling in the industry that it is ready to take off into fairly large volume. The biggest uses up to now have been in tumblers and battery cases and in water pitchers, jars, cups, etc. It is now being used and promoted in such products as liners for double-wall tumblers. The ANS inner liner resists staining from tea, coffee, or milk. Because of the material's chemical resistance and strength, bottles for pharmaceuticals and cosmetics are possibilities. In business machines it is suggested for keys, tab bars, rolls, and escutcheons. In refrigerators it is useful as a superior material for crispers and butter dishes. Eyes in dolls is an unusual application made to order for ANS. A complicated molding, using ANS's corrosion resistance to advantage is now going into telephone design (see photo, p. 94). One firm has been making casters for furniture from ANS for several years. Monofilament bristles, with outstanding chemical resistance, are used for industrial brushes.



Most of the talking about copolymers in the past year however, has related to the ABS copolymers. Part of the reason has been their move into the telephone hand set market where freedom from staining, particularly from cosmetics, has been a leading factor—and the material costs less than cellulosics. The telephone application is a 7- or 8-million-lb. market. Potential use of ABS in refrigerators has also aroused interest. One company has already installed ABS parts; two others are trying it out. The principal reasons for use are greater toughness and ability to take

more abuse than can the impact styrene types. The ABS plastics possess exceptional processibility, a glossier surface than impact styrene, have exceptional sheet-forming properties, and can take 180° F. temperature without deforming. ABS is used in pipe and fittings, transport applications such as (To page 193)

CELLULOSICS

Developmental work holds out hope that blow molding may open wide new area of application. But as of now, market for molding and extrusion material has leveled off . . . Polystyrene cutting into packaging film application market . . . Colored telephones mean partial loss of market to ABS . . . But despite general economic slump, 1960 over-all sales were only slightly off compared with 1959.

For a while in the early months of the year, it looked as if the cellulosics would post the 10% gain that had been predicted for them in 1960. But the general business downtrend and competition from other materials resulted in an over-all decline of about 3%, compared with 1959 volume. This decline took place almost entirely in the molding and extrusion classification (see Table, opposite). Cellulosic film and sheeting showed a slight increase in all but the "under-3-mil" types.

The industry has now reached a fairly level consumption pattern, with only minor fluctuations up or down; producers count on growth only in terms of population increase and economic growth. There also is a feeling among suppliers and processors that cellulosics have carved themselves a niche where their particular combination of properties—clarity and toughness—makes them the logical choice, and that that niche is safe from penetration by other materials.

Unlike plastics' big three (polyethylene, polystyrene, and vinyl), cellulosics have retained a high degree of price stability, and no one expects any significant price drops in the near term . . . especially since cellulosics are tied to movements of the wood pulp commodities market.

Film and sheeting. In the "under-3-mil" classification, oriented polystyrene made some inroads into the window-box and window-envelope packaging market, formerly a major outlet for acetate film. In 1959, film for window boxes accounted for 14.5% of under-3-mil acetate film production; for 1960, this percentage is expected to drop to 12 percent. For window envelopes, the annual percentage figures are 3.5 and 3%, respectively. But until certain adhesive, handling, and surface scratching problems have been solved for polystyrene, cellulosics will retain a position in this particular market.

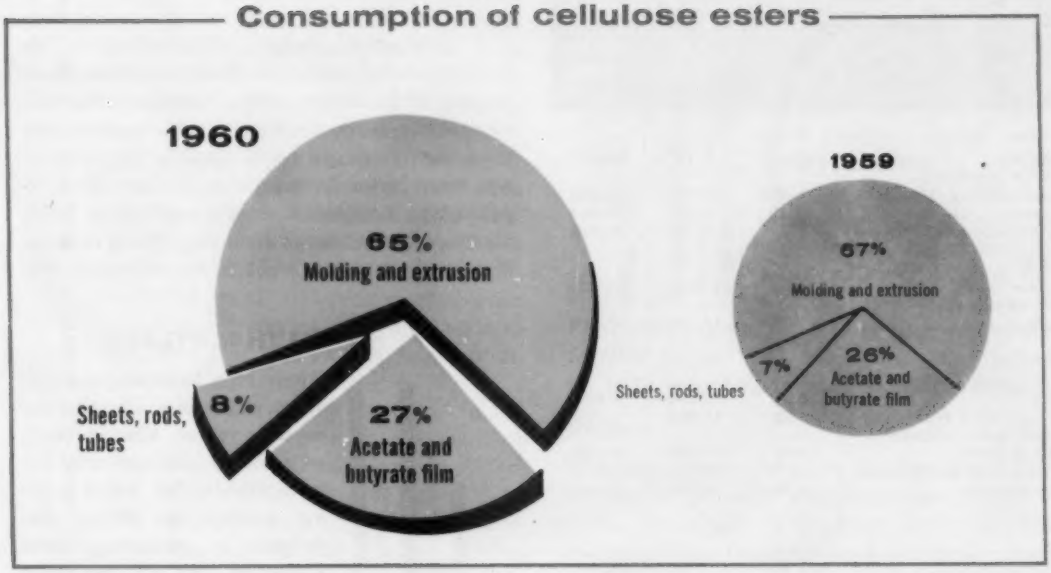
There were few new applications of under-3-

PRODUCTS USING PLASTICS IN LARGE QUANTITIES

Products[a]	1946	1958	1959	Est. 1960
Air conditioners (room units)	28,800	1,600,000	1,660,300	1,780,000
Floor type vacuum cleaners	2,289,400	3,295,000	3,420,830	3,396,880
Television sets	6,476	5,140,000	6,349,380	6,203,350
Refrigerators	2,100,000	3,116,700	3,785,000	3,425,000
Radios	15,953,000	11,200,000	15,622,000	17,650,000
Washing machines	2,020,200	3,668,000	3,833,300	3,300,000
Automobiles	2,148,700	4,257,000	5,599,000	6,700,000
Trucks and buses	940,800	877,300	1,121,000	1,150,000
Dwelling units (non-farm)	671,000	1,209,400	1,531,300[b]	1,300,000

[a] Factory sales in units. [b] Represents upward revision by Dept. of Commerce of previous estimate by Bureau of Labor Statistics. All estimates now done by Dept. of Commerce.

Consumption of cellulose esters



Cellulose plastic sales, 1956-1960[a, b]

Classification	*1956* 1000 lb.	*1957* 1000 lb.	*1958* 1000 lb.	*1959* 1000 lb.	*1960* 1000 lb.
Cellulose acetate and cellulose acetate continuous sheets:					
under 3 mils	19,400	18,000	16,300	19,025	18,702
3 mils and over	16,700	18,000	17,700	20,630	20,656
All other sheets, rods, tubes	7,000	7,200	8,600	9,506	10,528
Molding and extrusion materials	92,800	93,000	90,500	100,463	93,000
TOTAL	135,900	136,200	133,100	149,624	142,886
Nitrocellulose: sheets, rods, tubes	5,300	4,100	3,100	2,400	1,500

[a] Source: U. S. Tariff Commission, except 1960, which is estimated.
[b] Includes plasticizers, fillers, and extenders.

mil film in 1960, especially in the electric cable industry. It continues strong as sound recording tape (about 8% of the film goes into this application), maintaining its strong position in the non-professional, mass market. Polyester film is becoming a competitive factor, but a growing market is expected to assure a good volume for cellulosics. Polyester film is mostly used in video tape. The 8% figure is unchanged from 1959.

By far the largest market for under-3-mil film is in lamination. About 18% of "under-3-mil" continuous film went into it in 1960—same as for 1959. These laminations involve foil, PE and other plastics film, and paper. Gold stamping and metallizing tapes consumed 8.3% of under-3-mil film (up ½% from 1959). Pressure-sensitive tapes and electrical tapes, and miscellaneous applications account for the rest of the production.

In the over-3-mil category, vacuum forming took about 20% of the total output in 1960 (in this classification, half of the film is extruded and half is cast; vacuum forming took about 33% of the extruded stock). Acetate use for vacuum forming is expected to continue to grow at this rate, with rigid containers the brightest spot in this picture. This represents an increase of about 9% over 1959. Eyeglass frames took another 20%, fabricated rigid containers, 7% (the last two unchanged from 1959), and protective covers and folders, 16% (down 6% from 1959). The rest went into graphic arts, laminations, and miscellaneous.

The butyrate sheet market represents about 5 million pounds. Half goes into outdoor signs; packaging takes 30%; the rest is miscellaneous.

Molding and extrusion. There were three big

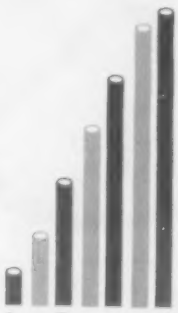
COST TABLE: Papers – Films – Foils[a]

MATERIAL[b]	Cost per lb.	Yield, sq. in./lb.	Cost per 1000 sq. in.
Glassine			
Bleached, 25 lb.[c]	$0.248	17,280	$0.014
Lacquer-coated, moisture-proof, heat sealing, 28 lb.[c]	0.455	15,428	0.030
Laminated, amber, 47 lb.[c]	0.30	9,191	0.033
Laminated, bleached, 47 lb.[c]	0.31	9,191	0.033
Waxed paper			
Bread-wrapper grade, 39 lb.	0.23	11,080	0.021
Liner grade, moistureproof, amber, 29 lb.	0.255	14,897	0.017
Cellophane			
Moistureproof, heat sealing (300 MS)	0.62	19,500	0.032
(300 MS 51 or MS-1 type)	0.62	21,000	0.030
Moistureproof, water resistant (300 MSA or MSB)	0.65	19,500	0.033
Polymer-coated (300 K, OX or R)	0.79	19,500	0.041
Polyethylene-coated	0.79	18,250	0.043
Cellulose acetate			
Cast (1 mil)	0.93	22,000	0.042
Extruded (1 mil)	0.74	22,000	0.034
Cryovac (60 gauge)	1.17	28,700	0.040
Pliofilm (SS-75)	1.10	33,000	0.033
Polypropylene (1 mil)	0.70	30,700	0.023
Polystyrene, oriented (1 mil)	0.60	25,400	0.024
Polyester film			
(1 mil)	2.25	20,000	0.112
(½ mil)	2.75	40,000	0.069
Heat sealing (2 mil)	2.35	13,400	0.175
Polymer-coated (½-mil base)	2.50	27,500	0.091
Polyethylene			
Low density (1 mil)	0.48	30,000	0.016
(1.5 mil)	0.48	20,000	0.025
Irradiated (Cryovac L, 1 mil)	1.05	30,000	0.035
Medium density (1 mil)	0.62	30,000	0.021
High density (1 mil)	0.62	29,000	0.021
Polyethylene-cellophane (1 mil poly-300 MS)	1.05	11,800	0.089
Saran (1 mil)	1.08	16,300	0.066
Vinyl			
Cast (1 mil)	0.87	21,600	0.040
Extruded (1 mil)	0.73	21,500	0.034
Foil-acetate (1 mil Al. foil-1 mil acetate)	1.50	6,490	0.232
Foil label stock (0.00035 Al. foil-30 lb. paper)	0.45	9,240	0.049
Aluminum foil (unmounted)			
Thickness, inches			
0.00035	0.843	29,300	0.029
0.001	0.708	10,250	0.069

[a] This comparison of approximate costs is intended only as a guide. The figures given were obtained from 1960 price lists and are based on "volume" orders. Courtesy, 1961 **Modern Packaging** Encyclopedia Issue.
[b] Typical packaging gauges, standard commercial grades, unprinted, are given here. The reader must understand there are other commercial grades, thicknesses and types.
[c] Based on a ream of 500 sheets, 24 by 36 in., or 3000 sq. ft.

facts that were responsible for the lower sales figures in 1960:

1. Colored telephones.—By the end of the year about 55% of all telephones were produced in color; and wherever that happens, cellulosics lose. While black telephones still consume considerable poundage of cellulosics, the colored sets mean lost cellulosics sales, and the 55-to-45 percentage breakdown of colored versus black phones will not remain for long. The percentage of colored telephones will continue **(To page 176)**



METHACRYLATE

There have been no great differences in sales situation for several years. Around 50% of molding material used for automobiles, for which market methacrylate-styrene copolymer is contending. Most important uses for cast sheet are signs, glazing and lighting. Impact material continuing steady growth. Methacrylate sirup for reinforced plastics is making considerable progress.

There was little change in the methacrylate situation in 1960 as compared with 1959. Prices remained the same for both monomer and polymer. There were no outstanding new applications in either molding material or cast sheet.

Automotive use still consumes more than one-half of molding material sales. It is used mostly in tail lights, dials and medallions. There may have been a slight decline in volume in this field in 1960—lights on standard model cars were smaller and the new compact cars use less than the larger automobiles. Inventories of methacrylate molding materials were heavy in 1959 but, once they were worked off, buying in 1960 showed none of the extreme ups and downs of previous years.

The threat of invasion of the tail light field by the methacrylate-styrene copolymer has not yet materialized, although experimental work and age-testing is still going on. If the copolymer should prove satisfactory it would pose a price challenge to currently used materials since it contains around 30% of 12¢ styrene monomer. Methacrylate monomer, in contrast, is 29¢ a pound. However, methacrylate producers give no outward evidence of disturbance over the possibility of severe competition for their automotive markets from the new copolymer. After many years of experiment and development of a superior and

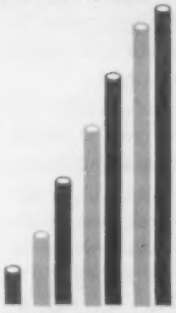
weatherable plastic, it is unlikely that they will submit easily to an attempted invasion by another thermoplastic into automotive applications.

Methacrylate has been used satisfactorily in automobile lights for 20 years and thus has a proven record of durability and weathering performance. During this time there have been steady improvements in the resin. Since it costs more than most thermoplastics, methacrylate has naturally acquired a hallmark of quality inherent in its clarity and freedom from sinks. Because of its high viscosity, or "hard" flow, compared to other thermoplastics, it requires educated molding technique. But once that education is acquired the molder has little trouble.

Suppliers have been largely successful in improving this flow property over the years. A molder may now choose from three general formulations: hard, medium, or soft flow. If he chooses the last, he may sacrifice some properties; for example, the soft flow material has less resistance to solvents or heat than do the other two. When molding for the automotive industry, he nearly always uses hard flow.

The use of methacrylate for medallions on large appliances such as refrigerators and washing machines declined somewhat in 1960 because production of the appliances fell off, smaller medallions were used, and lower-cost thermoplastics edged in to some extent. Molded brush backs, jewelry, lenses, and small signs absorbed about as much as usual. Outdoor light- **(To page 197)**

NYLON, ACETAL, POLYCARBONATES



Broadened market base for nylon expected as result of 20¢/lb. price reduction . . . but came too late to affect 1960 sales, which were slightly lower than in '59. Delrin, in its first full year of commercial production, showed up in more than 400 commercial applications. Price is now 80¢/lb., expected to go lower. Polycarbonates started to carve their niche, were 500,000 lb. in 1960, may reach 1000 million by 1970 according to some prognosticators.

Nylon

The biggest attention getter in nylon during 1960 was a 20¢/lb. price reduction. Cost is now 98 cents. The reason for the drop, according to the initiator, Foster Grant Co., was to create a broader market in housewares, housings, radio cabinets, air conditioning grilles, lighting fixtures, as well as in presently established markets. The hope was expressed that it would eventually become a popular priced thermoplastic. The company pointed out its own success in marketing nylon combs and sunglass frames as an example of potentials.

Nylon is now most generally used in specialized applications where it can do a better job by virtue of its self-lubrication, strength, and high heat resistance properties. In bushings, gears,

EXPORTS RELATING TO PLASTICS
(In millions of pounds)

Materials exported	*1957*	*1958*	*1959*	*1960[a]*
Urea and melamine plastics	19.6	21.0	24.8	12.4
Vinyl and vinyl copolymer resins, uncompounded	30.2	21.7	28.0	20.0
Vinyl and vinyl copolymer resins, compounded	15.1	21.0	26.3	12.1
Cellulosr molding and extrusion compounds	8.1	9.0	11.3	7.0
Vulcanized fiber	6.3	4.1	7.9	4.5
Styrene polymer and copolymer resins	63.1	89.0	112.7	68.9
Polyethylene resin, unfinished and semi-finished, except laminating film and sheeting	192.0	242.0	305.8	164.1
Polyethylene film and sheeting, except laminating	—	9.6	4.7	2.2
Ion exchange	—	1.7	7.2	4.9
Methacrylate	—	12.4	14.9	9.2

[a] First six months.

cams, and mechanized parts it is superb. But its relatively high price has probably been most influential in preventing its development into a large volume plastic.

Furthermore, nylon producers and molders are required to give more engineering and technical service than suppliers and processors of the lower-cost plastics in order to get it placed in "engineered" applications. Nylon is much less costly per cu. in. than brass in areas where it could compete on a "properties" basis in many applications, yet there are many difficulties involved in establishing these types of markets.

The argument over whether or not a lower priced nylon will increase the market to a sizable extent will probably continue for a long time to come, but as competition among the producers becomes more strenuous, it is reasonable to assume that further price declines are inevitable.

Nylon plastics sales in 1960 were slightly under 1959. No statistics are available and estimates are unreliable, but one brave soul guesses that consumption of nylon in 1960 was somewhere between 23 and 28 million pounds. Of this amount an estimated 4 to 6 million lb. was the caprolactam type, or nylon 6, produced by Allied, Foster Grant, and Spencer. The balance was Du Pont's nylon 6/6. Nylon began to move upward in much larger quantities than usual in 1958 and 1959, but hopes that growth would continue in 1960 were bashed by the general decline of the last quarter.

Use in automobiles now aver- **(To page 198)**

Acetal

Commercial production of Delrin, Du Pont's acetal resin (polymerized formaldehyde), started in January 1960. However, it had been in the hands of many molders for a year or more as an experimental material, and many of them were ready to go ahead with commercial products when it became available. More than 100 production molds had been built before Delrin came into production and there are now over 400 commercial uses. Growth has been faster than the anticipated sales.

Price was dropped to 80¢/lb. during the year, with constant reminders from the producer that it is expected to go lower as volume increases. The opening price had been 95 cents. Nylon, at 98¢, however, is less costly than Delrin since the specific gravity of nylon is **(To page 200)**

COST TABLE: Plastics for molded containers

Type of material		Base price[1] per lb. $	Specific gravity, molded	Cost per cu. in., cents	Color range	Molding method[5]
Acrylics	Clear	0.55	1.18	2.34		I
	Colors	0.59	1.18	2.51	Unlimited	
Cellulose acetate	Clear	0.52	1.3	2.44		I
Translucent	Colors	0.48	1.3	2.25	Unlimited	
Opaque	Colors	0.40	1.3	1.88	Good	
Butyrate	Clear	0.62	1.28	2.87		I
	Colors	0.62	1.28	2.87	Good	
"Delrin"	Natural	0.80	1.43	4.11	Unlimited	I
	Colors	0.89	1.43	4.57	Unlimited	I
Ethyl cellulose	Colors	0.67	1.15	2.78	Good[4]	I
Melamine[2]	Colors	0.47	1.50	2.55	Good[4]	C
Phenolics[2]	Brn. or blk.	0.195	1.36	0.96	Limited	C
Polyethylene	Natural	0.275	0.92	0.91		I
	Colors	0.315	0.92	1.05	Limited	
High density	Natural	0.35	0.95-96	1.21	Limited	I
	Colors	0.41	0.95-96	1.41	Limited	I
Polypropylene	Natural	0.42	0.90	1.36		
	Colors	0.51	0.90	1.66	Good	I
Polystyrene[2]	Clear	0.215	1.05	0.81		I
	Colors	0.255	1.06	0.98	Unlimited	
Modified styrene[3]	Natural	0.285	1.07	1.10		I
	Colors	0.325	1.07	1.25	Good[4]	
Ureas	Colors	0.34	1.50	1.84	Good[4]	C

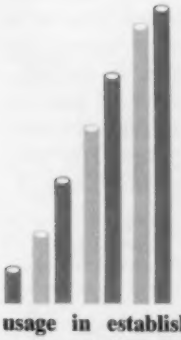
[1] The prices given here are those prevailing at the time this table was prepared. Current prices should be obtained for purposes of actual comparison.
[2] General-purpose grades.
[3] Available styrene acrylonite, $0.41 clear, $0.44 colors and methacrylate styrenes, $0.49 clear.
[4] In solid colors. [5] I—Injection molded. C—Compression molded.
Courtesy 1961 **Modern Packaging** Encyclopedia issue.

Polycarbonates

The most startling aspect of the start of commercial polycarbonate production in the United States in 1960 was the precipitous price decline that took place within the first six months of the introduction of the resin. Polycarbonates came onto market at $2.50/lb.; by year end they had gone down to $1.30. This is a drop of almost 50% within a period of six months and establishes some sort of a record. Further price declines can be expected, but they are not likely to be either as sharp or as rapid. Rather, they will be tied in closely with increased sales and greater acceptance of the new material. Estimates of future price levels vary, but by the end of 1961, the price of polycarbonate (general-purpose, injection molding grade) is anticipated to be down to around $1.10 to $1.15. By 1965 the per-pound price may be between 60¢ to 85¢. **(To page 201)**

POLYCARBONATES: ESTIMATED MARKETS FOR 1961

Application	*Resin sales* 1000 lb.	*Resin sales* %
Molding grade resins		
Safety and medical equipment	110	8
Appliances and lighting	140	9
Mechanical and transportation	250	17
Data processing equipment	290	19
Electrical and electronic products	350	23
Miscellaneous	110	7
Solvent cast and extrusion grade resins		
Photographic film base and miscellaneous film uses	250	17
TOTAL	**1,500**	**100**



FLUOROCARBONS

Three new resins were added to the fluorocarbon plastics family in 1960 . . . and producers now include Allied and Pennsalt as well as Du Pont and 3M . . . Total resin production increased, estimates going as high as 15 million pounds . . . No basically new applications, but increased usage in established markets—automotive, aircraft, missile, food processing and a variety of medical equipment.

The commercial introduction of new resins with promising future potential, and steady gains in established application areas, highlighted the year.

While production of fluorocarbon in resin form was relatively small in 1960, compared to the use of fluorocarbon materials in aerosol propellants and refrigerants (estimated to consume over 90% of *all* fluorocarbon output), it is in this plastics area that producers' research and development are most intensive. Estimates on fluorocarbon plastics volume for last year range from 12 to 15 million pounds. These estimates, if they give an accurate picture, would indicate that plastics account for from 4½ to 6% of total fluorocarbon production. This compares with a little over 7 million lb., or 3% of production, for plastics in 1950.

If, as some observers predict, total fluorocarbon production reaches 380 million lb. in 1965, a 10% representation by fluorocarbon plastics would equal 38 million lb., quite a respectable figure, and one which may prove too conservative!

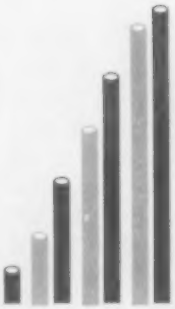
A big development in fluorocarbon resin chemistry last year was the announcement by Du Pont of the commercial availability of fluorinated ethylene propylene (FEP) resin, climax to 15 years of research and development. Unlike tetrafluoroethylene (TFE) resins, which must be processed in a manner similar to powdered metals, the FEP resin can be molded or extruded in standard thermoplastic processing equipment. The material retains the outstanding properties of TFE, such as chemical inertness, electrical insulating ability, high heat resistance (top service temperature for TFE is higher, but both resins will outperform most other thermoplastics in this regard), impact resistance at extremely low temperatures, virtually no moisture absorption, and excellent dry lubricating characteristics.

Specific end-uses cited for the new resin include jacketing for coaxial and multi-conductor cables, molded electronic components, laboratory tubing, and chemical process equipment linings. Commercial price is $11.60/lb. in truckload quantities. This, of course, is expected to come down as markets are developed. Price decline is exactly what happened in the case of the TFE resins, which were introduced around 1943 at $18/lb. and have since been lowered in price to $3.60/lb. for basic resin. The FEP material, designated

Teflon 100, is also available from Du Pont's Film Dept. as a film for use in coil-wound devices, capacitors, and printed wiring and circuitry. The film is priced at $15/pound.

Announced recently was the availability of experimental quantities of FEP monofilament fiber, in 250 and 1200 denier, equivalent to a cross-section diameter of 5 and 11 mils, respectively. Uses for the fiber are foreseen in chemical distillation and gas de-misting, and in vacuum filters.

Allied Chemical also entered the field of fluorocarbon plastics last year with Halon fluorohalocarbon resin, said to be somewhat similar to chlorotrifluoroethylene (CTFE) products now on the market, and with a modified form of the resin known as Aclar film. Both products are being made in developmental quantities by Allied's General Chemical Div. The resin is available in two grades, one emphasizing high impact resistance and the other designed for high heat resistance. Both are said to have good electrical properties, transparency in thicknesses up to ⅛ in., and very low permeability to water, oxygen, and carbon dioxide. Expected applications are in cable jacketing, chemical gasketing, antiseptic medical equipment, and moisture-free electrical components. The resin is priced at $4.60/lb. for quantity orders. No set price has been given for the Aclar film, which is expected to see use as packaging for delicate electronic parts. **(To page 205)**

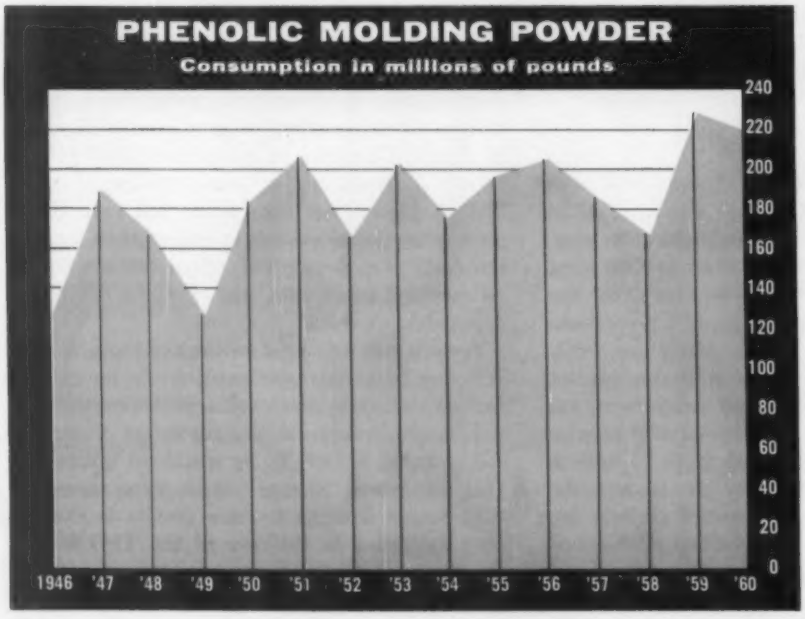


PHENOLICS

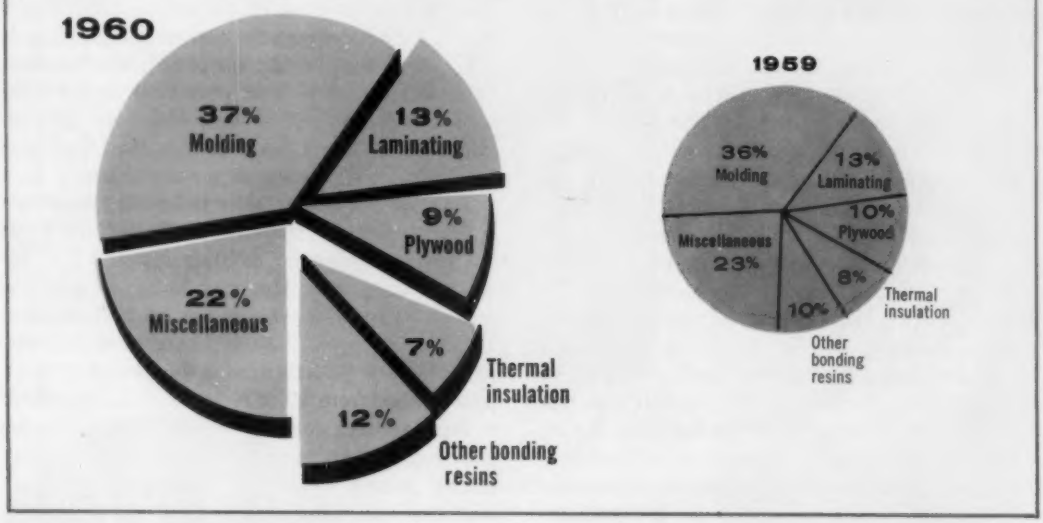
Molding powder sales fell off in last quarter after good first half year. Price of both molding and industrial phenolics was raised during 1960. No particularly new applications, but use of phenolic bonding resins appears to be fastest growing section of industry.

A leap from the barrier at the beginning of 1960, which looked as though it might outleap all previous phenolic-molding powder start-off leaps, featured the phenolic industry's progress in 1960. But the big leap forward in early 1960 must have worn out the industry muscles, for there wasn't enough energy left to keep up the fast pace that was set from January through June. During that period, the industry was operating at an annual rate of well over 200 million lb.; the 1960 total would have broken all records if second-half sales had even matched the nearly 120-million-lb. volume in the first half. The previous record production for a year was a little over 229 million lb. in 1959, with a sales volume of about 214 million pounds.

The big first half of 1960 was simply a carryover from the record volume in 1959. This puts the 12-month production period from June 1,



Phenolic production by end uses



Phenolic resin production[a, b]

	1956	*1957*	*1958*	*1959*	*1960*
	lb.	*lb.*	*lb.*	*lb.*	*lb.*
Molding materials	204,000,000	184,000,000	168,000,000	229,000,000	220,000,000
Laminating resins[c]	70,000,000	74,000,000	63,000,000	95,000,000	90,000,000
Abrasives	16,500,000	17,000,000	12,000,000	17,000,000	14,500,000
Friction materials brake linings, etc.	16,000,000	16,000,000	13,000,000	17,000,000	15,500,000
Thermal insulation	55,000,000	53,000,000	45,000,000	52,000,000	40,000,000
Plywood	42,000,000	47,000,000	52,000,000	62,000,000	52,000,000
All other bonding resins[d]	32,000,000	51,000,000	40,000,000	64,000,000	70,000,000
Protective coatings[e]	26,000,000	50,000,000	53,000,000	60,000,000	60,000,000
Resins for all other uses	37,000,000	40,000,000	42,000,000	42,000,000	40,000,000
TOTAL	498,500,000	532,000,000	488,000,000	638,000,000	602,000,000

NOTE: Production figure is used here rather than consumption figure as in other tables since a large part of industry is captive and production figure is thought to be more truly indicative of actual consumption and difference between production and sales figures is relatively minor. [a] Source: U. S. Tariff Commission, except last 4 months of 1960 which is estimated. [b] All on solid resin basis except molding materials, which includes about one-half filler. [c] Note rise in 1959, since the Tariff Commission's figure is deemed unusually low because captive operations consume large quantities of resin that is not reported. Even the figures used in this table are probably well under total consumption for laminating resins. [d] Variations in reporting by various companies indicate that resins reported here sometimes belong in "resins for other uses" and vice versa. [e] The year 1956 does not include certain rosin-modified resins that were reported under modified rosin esters.

1959 through June 30, 1960 in the record books with a total of probably 235 million pounds.

No one seems to know exactly how to account for this phenolic molding powder behavior. The chart on p. 108 shows that phenolic has violent up and down movements, probably more so than other plastics. Many reasons are given for this situation. War periods, for example, put phenolic in extremely heavy demand because of its electrical properties. Similarly, development of a big, new end use such as television cabinets can cause more than an average rise to one year's production; or, on the other hand, when some big application, such as that same television cabinet, is lost to the industry, there can be a serious decline.

The most common explanation for phenolic behavior is, however, that phenolic molding powder is now 50 years old and mature enough to follow the general course of all business. For example, the big production since Jan. 1, 1959 was a direct reflection of the 1959 steel strike. Supposedly customers bought all they could get their hands on before the strike and kept on buying phenolic during the strike to use with steel they had on hand.

There was no real slow-up in purchases of phenolic (primarily for electrical, construction and the appliance industries) until July 1960—and this despite the fact that the construction and appliance industries had a relatively bad year. Even August was a pretty good month, with over 15

million lb. produced. September sales topped the 22-million-lb. mark; but that volume was due to an announced price increase which customers were trying to beat. The last three months of 1960, according to all reports, were way down.

It seems that there must be a lot of inventoried phenolic and phenolic parts on hand—but we felt exactly this way one year ago, and yet the first half of 1960 was almost phenomenal. Sales in the third quarter were considerably less than in the same period of 1959, and final figures for the fourth quarter will show but slight improvement.

So how can one tell what is going to eventually happen in phenolic molding material? One producer says it may go down to 170 or 180 million lb. in 1961, and continue to decline because of competition from other plastics. Another says that such speculation is extremely foolish, that the industry total may reach 250 million lb. before 1965, depending upon the general economy. Optimistic to the point of putting money on the line is Reichhold Chemical Co., which is planning to build a new molding powder plant despite the fact that the current over-all capacity of the industry must be at least 25 million lb. a month, with sales that average only 16 or 17 million.

Incidentally, the highest production month on the record was 22.1 million lb. in April of 1960. The monthly production figure had not gone below 18 million in any month from Aug. 1959 to July 1960. This indicates a good healthy situation even if at a small profit since it seems that the industry keeps busy without much time for wailing when it consumes 16 million lb. of compound or more per month.

The lull in the last half of 1960, and that which probably will occur in early 1961, will create scalding tears and mournful weeping in some houses, but the phenolic molding industry is far from sick—it will be right back up there when steel, construction, appliances, and automobiles get back on the track. Of course, it could be 80 or 90 million lb. greater if it were not for competition from other plastics; but this isn't the first time that an industry's growth has been leveled off by competition from other materials.

After all, the industry has grown from about 100 million lb. in 1945 to around 200 million in 1960, which isn't a bad record for a business that required over 30 years to get up to a 100-million-lb. volume.

The pessimists who fear a decline starting about 1962 expect competition from the new, higher-heat-resistant thermoplastics and possibly from a lower-cost melamine that has been a dream for many years. The optimists, on the other hand, discount the thermoplastics. It is their contention that thermoplastic heat resistance still won't be high enough to match that of phenolics; that phenolic is still a low-cost material (its per cu. in. price is lower than most metals; see p. 85); that the electrical industry, which is phenolic's largest consumer, is destined for a long, continuous upsurge; and there is always the possibility that some new application will develop large-volume use.

Another interesting factor to be taken into consideration is price stability. In the last 10 years the price of phenolic molding material has advanced only 1 cent. The price history of a typical compound indicates that it was $0.1970 in Dec. 1950 and is now $0.2070. There were intermittent, temporary fluctuations in this period in which prices varied from $0.1870 to $0.2120, but where is there another commodity with such a narrow price range? This same compound (one of many among scores of general purpose phenolics) started in business at 17¢ in 1932. It has gone as low as 13½¢ (staying there during war time when prices were frozen) to 21.2¢ in 1957, thus leaving an impressive record in price history. During this same 25-year-period, automobiles have increased in price by three-fold, and most other products have tacked on similar sizable increases.

The general good health of the phenolic industry was signified last fall when the price for most general purpose compounds was raised from 19½ to 21¢, in contrast to most thermoplastics, which have been declining. One-step closure materials went up only one-half cent, but since they were 20½¢ previously, this now puts them in the same category as the more commonly-used general-purpose materials.

Like most other plastics, the phenolics vary in properties and formulations according to their intended end use. Consequently, there is no one over-all price for all types, but the 21¢ mentioned above applies to the largest portion of formulations. One company lists 24 formulations of black or brown general-purpose, with a price range of from $0.207 to $0.27. The latter is a two-step material of premium quality, with improved impact strength and excellent machinability. The lowest cost material has a high specific gravity but cures faster in thick sections. Most of these 24 materials also have from one to eight different plasticity grades indicating flow properties. But different flow rates do not alter the properties of the molded product as is customary in most thermoplastics. Specific gravity of the above 24 resins also varies from 1.36 to 1.46, and bulk factor from 2.3 to 2.7. Both variations affect cost per cu. in. of finished product, but they are designed

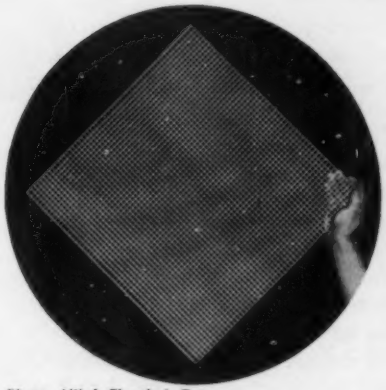
APPLICATION HIGHLIGHTS—1960

NYLON PROVED to be competition for metal in the builders' hardware market in 1960. In the mechanism for a lockset, the resilience and low-friction characteristics of the nylon provide quieter operation and eliminate the need for lubrication. Tests showed that after 1.2 million cycles—equivalent to at least 80 years of use—the unlubricated locksets operated even more smoothly than ever before. Look for nylon to move into similar markets—including housings for small appliances—in 1961.

Photo, Du Pont

Photo, Hooker Chemical Corp.

THE INFLUENCE OF PHENOLICS on rocket and missile design in 1960 was readily apparent in the use of a thin nose cone (molded of a flexible nitrile rubber-bearing, flock-filled phenolic) to protect the delicate mechanism of this anti-submarine rocket. The compound has exceptional toughness and shock resistance coupled with good impact strength. For the torpedo head, the molded cap is specially designed to break and fall away at the instant the homing guidance mechanism goes into operation.



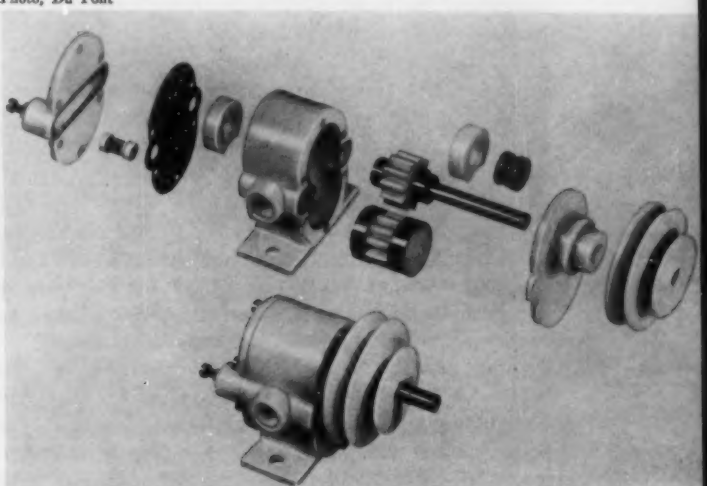
Photo, Allied Chemical Corp.

THE INTRODUCTION by Edwin F. Guth Co. of a molded urea light diffuser to meet revised fire code ordinances in various metropolitan areas highlighted the year for urea. In use, an even illumination is provided by ceiling of light composed of molded urea louver gratings, which are suspended from special ceiling fixtures. Gratings diffuse light through more than 3000 openings molded in the part.

Photo, American Cyanamid Co.

IN A TAKE-OFF on the use of molded-in foil overlays to decorate melamine dinnerware, a major manufacturer adapted the technique in 1960 to the production of decorated melamine handles for kitchen utensils. A second manufacturer, introducing a molded urea wall plate similarly decorated, lent weight to what may turn out to be a trend toward the use of the foil decorating technique, originally confined to flat dinnerware, to other consumer and industrial applications in 1961.

Photo, Du Pont



THE USE OF ACETAL RESIN in a general-purpose gear pump—the first ever designed from scratch in a thermoplastic material—broadened plastics' market base in the area of "engineering materials" in 1960. As used in the pump, the plastic design reduces horsepower requirements as much as 50% over comparable metal models; more than doubles service life; and virtually eliminates maintenance. The pump may be mass produced economically with a minimum spare parts inventory.

to fit the required properties of different products, ranging all the way from closures to various types of electric applications.

This same company also has seven colored phenolics with prices ranging from 26½ to 36¢; three heat-resistant types from 21 to 28¢; a chemically resistant material at 34½¢; four impact materials at from 26¼ to 28½¢; and 16 electrical insulating grades at from 30½ to 42½¢, with the latter suggested particularly for high-frequency applications. The other electricals **(To page 206)**

REINFORCED PLASTICS

Despite slump in boat business, reinforced plastics showed only minor losses over 1959 figures. Taking up the slack was growth in RP use for transportation, containers and trays, pipe and ducts, and electrical applications. Transportation markets showed the largest increase . . . motor transportation uses up 18%, aircraft and missiles use up 10 percent. Expectations for the over-all reinforced plastics market by 1965 range from 500 to 600 million pounds.

Considered in terms of total poundage of reinforced plastics sold, 1960 was 1959 all over again —or almost. Considered market by market, it was something else again. For the first time since the material was mustered out of military service in 1947, the industry halted its uninterrupted climb in volume and took a hard look at its markets. A breakdown of these markets is given in the table on the following page.

To a large extent, reinforced plastics in 1960 were the victim of their own success. A booming boat market in 1959 absorbed 27% of the materials, actually creating a shortage in glass. It was this luxury market that was hard hit in the uncertain business climate of 1960, overshadowing the continuing increases in use of reinforced plastics by other product groups. Alone, the decrease in boat sales in 1960 more than accounted for the 12-million-pound drop in reinforced plastics poundage last year from the 264-million-pound record high of 1959. This 252-million-pound total for 1960 was approximately 4% under that of the preceding year.

The consumer product market, too, showed the effect of postponed purchases of luxury goods and, in a more important consideration for the long range, the growing competition of plastic with plastic. Industry opinion as to exactly how this market fared last year varies considerably, depending on what is and what is not considered to be a "consumer" product. There is general agreement, though, that products not requiring reinforced plastics' bonus of strength—planters and window boxes, for example—showed an increasing disposition to switch to the more highly automated production procedures that are possible with thermoplastics.

So much for the minus side. In the remaining seven of reinforced plastics' nine major markets total poundage use was up in four (transportation, containers and trays, pipe and ducts, and electrical applications) and held even in three (construction, appliances, and aircraft and missiles). Actually, construction should be counted on the plus side. Although poundage held at an estimated 37 million lb., square footage of paneling (which accounts for most of this market) went up between 10 and 15 percent. The explanation for the divergent figures lies in a definite trend toward lighter weight building panels.

Transportation was the single market to show a greater percentage gain in use of reinforced plastics in 1960 over 1959 than in 1959 over 1958. It now figures as the second largest outlet for these materials, outranked only by boats.

For the 1960 calendar year, use of reinforced plastics averaged out to between 3 and 4 lb. per passenger car. The effects of 1961 models on total volume are yet to be felt. In the case of the 1961 Chevrolet Corvette, for example, General Motors not only decided to continue use of the reinforced plastics body (which rumor has "being abandoned" each year) but also authorized the Molded Fiber Glass Body Co. to retool to permit a 50% increase in volume.

One of the most interesting new reinforced plastics applications is a molded phenolic-glass, one-piece, snap-in-place headliner for American Motor's Rambler Classic 6 and V-8. Both in performance and in economy, it bids fair to outmode fabric liners. (See MPI, Nov. 1960, p. 86).

Glass was, and is, a key factor in reinforced plastics progress. Through much of 1959, even into 1960, glass reinforcement was in short supply, even for established applications. But the unforeseen drop in the boat business as against an anticipated 1960 increase of 15 to 20% has changed the situation, first to one of easy availability of glass filament, and then into one of excess capacity. Today, capacity for producing continuous glass filaments is variously estimated at from 40 to 60% above that of 1959. It would be

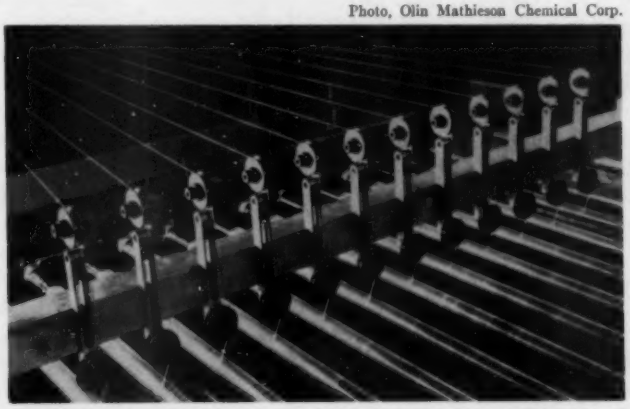
APPLICATION HIGHLIGHTS—1960

STYMIED BY A DROP IN THE BOAT BUSINESS, reinforced plastics molders in 1960 trained their sights on developing such new applications as these club compartment seats for the Convair 880 jets. Adaptability of RP molding to the free styling required, extreme lightness, and strength influenced the choice. Pre-impregnated materials were used in preference to wet-lay-up because of quality control and economy.

Photo, Heil Process Equipment Corp.

AND REINFORCED PLASTICS PRODUCTS grew bigger and bigger in 1960! Made by hand lay-up using glass-reinforced polyester resin, this huge fan housing measures 11 ft., 3 in. long by 11 ft., 3 in. high, by 5 ft., 4 in. wide. The equipment is designed to handle sulfuric acid fumes, and the corrosion resistance of the RP completely eliminates any possibility of rust or other corrosive attack.

Photo, Olin Mathieson Chemical Corp.



↑ **FILAMENT WINDING,** long familiar to the industry for jet-assist take-off bottles and pressure vessels, expanded into new areas in 1960. The most unusual application was the first plastic gun barrel ever produced. The barrel is made by spinning epoxy-impregnated fibers around a thin cylindrical metal liner (above). The result: greater burst strength than would be possible for steel; corrosion resistant, heat absorbing qualities that eliminate hot barrels and heat wave distortion; lighter weight (30% less than standard gun barrels); and lower cost. Look for more RP applications involving filament winding in 1961!

Photo, Owens-Corning Fiberglas Corp.

← **A COMPLETELY NEW CONCEPT IN RP** auto applications: a molded phenolic-glass headliner more versatile, tougher, and easier and more economical to install than sewn fabric liners. The part weighs only 5 lb., and, as used in American Motor's 1961 models, provides more head room. The liner is made up of two halves, with a sheet of 3-mil high-density PE film in-between as the binder.

REINFORCED PLASTICS MARKETS, 1960 vs. 1959

Major markets	1960/lb.	Percentage of '60 Total	1959/lb.	Percentage of '59 Total
Aircraft and missiles	37,000,000	14.7	37,000,000	14
Appliances	10,750,000	4.3	10,750,000	4
Boats	58,000,000	23.0	71,000,000	27
Construction	37,000,000	14.7	37,000,000	14
Consumer	32,000,000	12.7	34,000,000	13
Containers, trays, industrial housings	11,500,000	4.6	10,750,000	4
Electrical	11,500,000	4.6	10,750,000	4
Pipe, ducts, tanks	8,250,000	3.3	8,000,000	3
Transportation	39,250,000	15.5	34,000,000	13
Miscellaneous	6,750,000	2.6	10,750,000	4
TOTALS	252,000,000		264,000,000	

even higher had not many of the glass reinforcement manufacturers cut their expansion plans in mid-year because of the drop in the boat business.

There is, today, plenty of glass-drawing capacity to meet the industry's needs for at least the next three years; and plant facilities now are such that output could be increased if necessary without the time lag experienced in 1959 and 1960.

Much of today's development work will not show up in industry sales figures for a year, or even two. For example, late 1963 is the earliest date at which a passenger car radiator housing, which is reportedly well along in testing, could possibly go into volume car production.

For the coming 12 months, sales of reinforced plastics are expected to total in the neighborhood of 270,000,000 to 280,000,000 pounds. This represents a 7 to 11% increase over sales of 1960, a 2 to 6% increase over the record 264,000,000 lb. reported for 1959.

The 1960 hiatus in the industry's growth is expected to have but slight long-range effect. In fact, a majority of the resin and reinforcement companies queried on the subject still hold to a projection of 525 million lb. by 1965. A few predict that it will be 1967 before this total is reached.

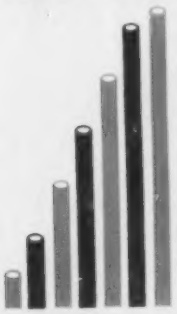
Transportation; construction; boats; aircraft; pipe, ducts, and tanks, in that order, are the markets expected to register the greatest gains in 1961 as compared to 1960. Estimates on growth of the market for containers, trays, and industrial housings for the coming year vary from 2 to 15% and average at 4 percent. Opinion regarding the immediate future of the three remaining markets—electrical, consumer, and appliances—shows a wide divergence.

One reason for this divergence is that there has always been a question as to whether the industry figures give a true picture of the use of reinforced plastics in electrical parts. How much poundage reported as miscellaneous, as aircraft and missiles, as transportation, as appliances, rightly belongs under electrical? Use of pre-preg materials and pre-mix, or molding materials, are known to have made substantial gains in this field. The great imponderable is the captive plant operation. As for the appliance and the consumer products markets, the immediate figure would seem to be one of some attrition.

For the long range, there are two yet-to-be-resolved production factors in reinforced plastics' future. Most important is the need for more highly automated, time- and labor-saving means of production. Secondly, a means of producing better, more consistent, straight-out-of-the-mold surface finish could go far toward reducing finishing costs and speeding up the production line. It isn't that the industry has not made gains on both these fronts. It has. A few years ago, molding cycles ran in the neighborhood of 3 to 5 minutes. Today, they are down to 20 to 50 seconds. It is just that more is needed.

Closely tied to this production research and development, and to product development as well, is the overall financial position of the industry. The continuing entrance of large **(To page 212)**

UREA and MELAMINE



Sales of amino resins kept close to 1959 figures. Slight losses attributed primarily to drop in resin sales to the hardwood plywood industry. Melamine dinnerware sales off by about 5% —but optimistic producers still anticipate 100-million-lb. market by 1965. Resin use in chipboard showed year's healthiest increase. Urea molding powder sales held their own, despite increased competition from thermoplastics in closures.

Sales of urea and melamine resins in 1960 hewed closely to the same pattern of selling that had characterized 1959. No dramatic new applications were developed nor was there any unusual growth observed for standard applications. And when the final figures were totaled, 1960 sales fell only some 20 million lb. short of 1959's record 383.5 million pounds.

In the early months of 1960, expectations based on January and February sales had been for an over-all 5 to 10% increase in volume. When the general decline in business conditions hit the country around mid-year, however, estimates were revised considerably downward. But again, the experts proved wrong in their estimates of the seriousness of the decline. In the final analysis, 1960—with its 361.5 million-lb. sales figure—was still a relatively good year for melamine and urea. The only real disappointment was in the failure of the expected gains to materialize.

As far as individual categories are concerned, there was no serious deviation one way or another from 1959 figures. The amount of resin going into textile treating and coating fell about 3½ million lb. from 1959's 40 million lb., and the amount of resin going into paper treating and coating held about even with 1959 at 28 million pounds. It is becoming apparent that both applications may be reaching some sort of saturation point. Since 1955, textile resins have kept to an annual sales figure between 38 million and 42 million lb., paper resins to an annual sales figure between 23 million and 28 million pounds.

Urea and melamine resins for laminating was one of the few categories to show an increase—from 29.5 million lb. in 1959 to 31 million lb. in 1960. Architects in 1960 were showing an increasing awareness of the versatility of decorative laminates for such applications as sliding doors, wall shelving, counter spaces, and hi-fi consoles. Complementing as they do traditional markets for laminates in furniture and counter tops, these applications should do much to foster growth in the coming 12 months.

Manufacturers of decorative melamine laminates were also closely watching **(To page 214)**

UREA AND MELAMINE RESIN SALES[a]

Uses	1957 lb.	1958 lb.	1959 lb.	1960 lb.
Textile treating and textile coating resins	38,000,000	42,000,000	40,000,000	36,500,000
Paper treating and paper-coating	23,000,000	23,000,000	28,000,000	28,000,000
Bonding and adhesive resins for:				
Laminating[b]	23,900,000	27,000,000	29,500,000	31,000,000
Plywood	94,500,000	105,000,000	104,000,000	84,000,000
All other bonding and adhesive uses[c]	9,900,000	12,000,000	23,000,000	31,000,000
Protective coating resins, straight and modified	26,800,000	25,000,000	27,000,000	26,500,000
Resins for all other uses, including molding[d]	105,300,000	92,000,000	132,000,000	124,500,000
TOTAL	321,400,000	326,000,000	383,500,000	361,500,000

[a] Source: U. S. Tariff Commission, except last three months of 1960, which is estimated. [b] Laminating resins were included in "all other uses" prior to 1957. [c] This figure includes resins used for chipboard and commercial adhesives—prior to 1957, it included laminating resins. [d] Includes filler. The total for 1960 includes about 56 million lb. of melamine molding material and about 38 million lb. of urea molding material. Exports of all types are now included in this figure, but in other years were divided among various items.

In these flame tests, one epoxy strip ignites and burns rapidly; the other, containing Aroclor, won't ignite at all.

AROCLORS are COMPATIBLE with virtually all plastics resins • polyvinylidene chloride • cellulose acetate propionate • polyvinyl acetate • chlorinated rubber • ethyl cellulose • benzyl cellulose • polystyrene • nitrile rubber • phenolics • polyamides • epoxies • acrylics • urethanes • polyesters • polyethylene • nitrocellulose • polyisobutylene • styrene-butadiene • polyvinyl butyral • polyvinyl chloride • cellulose acetate butyrate

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NONBURNING EPOXIES

Aroclors are fully compatible with epoxy resins. Combined with a small amount of antimony oxide, they produce *nonburning* compositions. Aroclor 5460 yields epoxies with optimum compressive strength. Aroclor 1221 greatly improves flexibility.

	AMINE-CURED EPOXIES		PHTHALIC ANHYDRIDE-CURED EPOXIES	
formulation	**control**	**modified**	**control**	**modified**
liquid epoxy resin	100	100	100	100
diethylenetriamine	13	13	...	...
phthalic anhydride	...	...	75	75
antimony oxide	...	5	...	5
DMP 30 (Rohm & Haas)	...	...	0.1	0.1
AROCLOR 1260	...	15	...	...
AROCLOR 5460	...	...	...	15
properties				
compressive strength, *psi*	43,000	38,150	23,400	40,700
flexural strength, *psi*	20,100	22,100	16,900	19,000
heat distortion, °C.	117.5	92	143	135
FLAMMABILITY— *inches per minute* (ASTM D635-56T)	0.82	NON-BURNING	0.6	NON-BURNING

EXTENDERS FOR PVC

Aroclors are especially effective as secondary plasticizers or extenders for polyvinyl chloride. Aroclor 1262, used 1:3 with dioctyl phthalate, sharply reduces migration to nitrocellulose lacquers. All Aroclor compounds can be used to improve the chemical resistance of vinyl chloride–vinyl acetate coating formulations.

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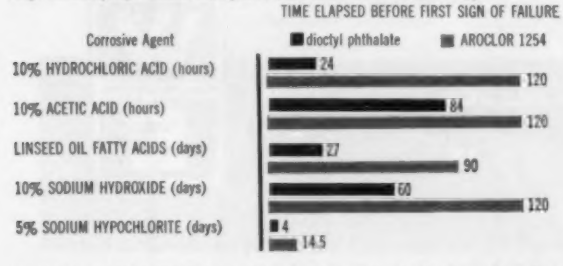
vinyl chloride/vinyl acetate copolymer; plasticizer concentration: 25%



***Plotted from independent evaluation data by the Northwestern Paint and Varnish Production Club** (The Official Digest, Nov. 1955).
Conclusion: **"The Aroclor 1254 had the best all-around chemical resistance."**

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Aroclor 5460 gives self-extinguishing, low-density polyethylene *with minimum effect on tensile strength or "memory."* Aroclor 5460 substantially improves heat stability, too, compared with other common flame retardants.

LOW-DENSITY POLYETHYLENE

formulation	**control**	**modified**
polyethylene	100	70
antimony oxide	....	10
AROCLOR 5460	....	20
properties		
melt index	1.96	6.2
% elongation	655	650
tensile strength, *psi*	2130	1710
yield strength, *psi*	1395	1300
FLAMMABILITY— *inches per minute*	7.1	SELF-EXTINGUISHING

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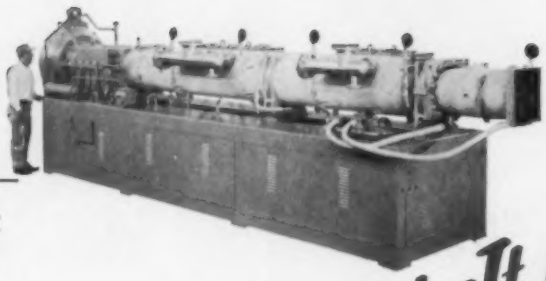

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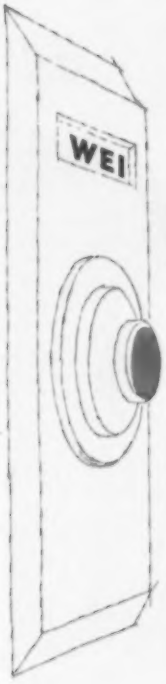

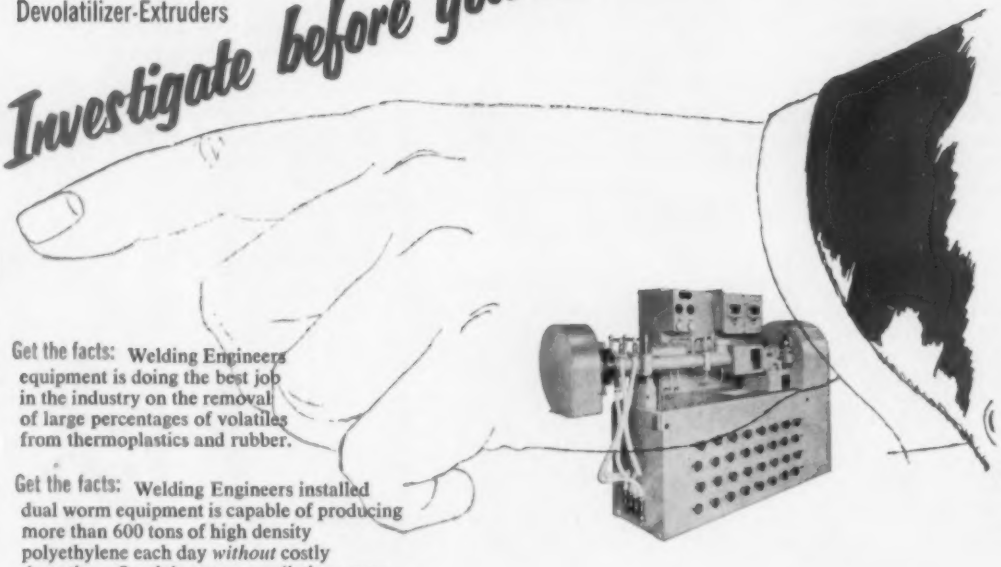

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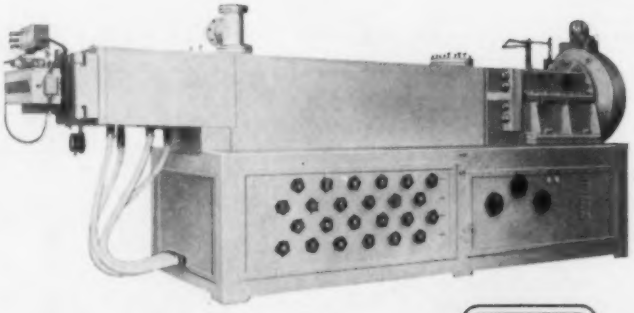

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Machinery for plastics

Machinery makers turned in creditable sales performance for 1960 in light of over-all economic slack last year

The plastics processing equipment industry was one of the few to buck the general economic turndown that characterized 1960. Our survey of plastics machinery manufacturers revealed an overall increase in sales in 1960, as compared with the 1959 performance.

Of course, the rise in sales is based on industry-wide totals; some individual machinery firms reported declines. Nor were the year's sales increases divided uniformly among all types of equipment. For example, extruder equipment showed a net increase of 17 percent. Sales of thermoforming equipment were up about 20 percent. Sales of compression presses were about the same as last year, based on the results received. And, as might be expected, the new blow-molding machinery industry ran up a whopping sales increase of 72% over 1959.

The only blue note in the picture was the sales of injection machines. Some individual firms gained ground, but others registered sufficient loss to result in a net sales decline of about 13 percent.

The distribution of sales among injection machines in terms of size remained about the same as it has for about the past four years. About 90% of the machines sold were of the 18-oz. shot size or smaller; 60% of the sales were machines 7-oz. and under; and about 32% of all sales were machines 2.5-oz. or less in size.

As far as the distribution of extruder sales were concerned, only about 8% of domestic sales were for very large machines. About 72% of the machines sold had screws with diameters 3.2 in. or under, and the bulk of the sales was in the 1.7+ to 3.2-in. class. Furthermore, extruders under 3.2 in. also exhibited the largest rate of growth in 1960, probably reflecting to some extent the rapid growth of blow-molding machines, which require use of an extruder of this size.

Response to the survey by manufacturers of thermoforming equip-

*Reg. U.S. Pat. Off.

Table I: Sales of Injection Machines

NUMBER OF MACHINES

Nominal shot capacity, oz.	Domestic			Export		
	1958	1959	1960	1958	1959	1960
2.5 or less	262	394	353	6	23	20
2.5+ to 7	286	358	312	10	10	17
7+ to 10	92	120	116	10	5	7
10+ to 18	256	283	193	14	8	5
18+ to 29	36	53	80	2	2	4
29+ to 55	33	13	6	4	0	2
over 55	35	31	32	3	2	5
All sizes	1000	1252	1094	49	50	60

Table II: Sales of Extruders

NUMBER OF MACHINES

Nominal screw diameter, in.	Domestic			Export		
	1958	1959	1960	1958	1959	1960
1.7 or less	123	128	214	21	10	15
1.7+ to 3.2	249	353	450	44	38	47
3.2+ to 4.2	190	240	242	35	30	42
4.2+ to 6.5	178	273	253	39	29	55
over 6.5	67	90	107	9	10	31
All sizes	807	1084	1266	148	117	190

Table III: Sales of Thermoforming Machines

NUMBER OF MACHINES

Heater area	Domestic			Export		
Sq. Ft.	1958	1959	1960	1958	1959	1960
3 or less	165	230	267	5	4	5
3+ to 6	58	111	147	1	2	0
6+ to 12	68	82	100	4	1	4
12+ to 18	21	13	23	0	8	0
18+ to 30	15	41	44	0	3	5
over 30	6	12	6	0	0	0
All sizes	333	489	587	10	18	14

Table IV: Sales of Blow Molding Machines

NUMBER OF MACHINES

Type	Domestic			Export		
	1958	1959	1960	1958	1959	1960
Used with extruder	4	84	135	7	4	9
Self-contained	12	2	13	0	0	1
All types	16	86	148	7	4	10

Table V: Sales of Compression Presses

NUMBER OF MACHINES

Nominal size	Domestic			Export		
Tons	1958	1959	1960	1958	1959	1960
50 or less	335	387	387	11	16	34
50+ to 100	117	137	137	1	1	1
100+ to 200	57	71	61	0	0	0
200+ to 300	14	16	16	0	0	0
300 and over	33	45	33	0	0	1
All sizes	556	656	634	12	17	36

ment was poor this year. However, the replies received did allow for some analysis of the market for this type of equipment. Results received indicated that machines with 12 sq. ft. or less of heater area still account for about 87% of all sales and that the sales of large machines are not increasing significantly; they may even be declining as far as the largest sizes are concerned. The smallest machines, those of the 3-ft. size, still account for the bulk of all sales.

Since no one has as yet come up with a good way of classifying blow-molding machines according to their capacity, reports of sales of these machines are broken down into only two types: those requiring an extruder and those which do not. About 90% of the sales are for the extruder-fed machines.

This is the second year in which we have surveyed compression press manufacturers. No attempt is made to report on the total number of operable machines in the field because of the difficulty of establishing the number of machines sold and put into service in earlier years. The distribution of sales by machine size has been for the past three years exceptionally consistent—about 60% of the machines sold are of 50 tons or under. Estimates for total 1958 sales have been adjusted in line with adjustments of 1959 sales figures reported to us along with the 1960 sales results.

Trends

This year, in addition to asking simply for sales figures, we attempted to find out from machinery manufacturers four other items of information: 1) who was buying the machinery; 2) what it was to be used for; 3) what customers wanted to see in new machines; and 4) whether competition from foreign machinery makers was becoming a problem. Based on the replies we received from the machinery makers, here are the trends.

Most of the extruders, thermoforming machines, blow molding machines, and compression presses are being sold for use in either proprietary or captive manufacturing operations. This confirms a definite departure in the industry from its historical custom supplier character. Only in the injection field does it appear as if the custom processor has remained the principal purchaser of equipment.

New injection machines in 1959 and 1960 were mainly purchased for the molding of packaging, appliance parts, and other industrial parts. A fourth—and still growing—outlet which showed up in 1960 was housewares. As would be expected, most of the new extruders sold in 1960 appear to be going into the production of film and coated products or to be used in conjunction with blow molding equipment. Blow-molding machines operating off extruders were making toys and housewares in 1959. However, in 1960, it appears that bottles and containers have replaced toys as a major outlet for the blow-molding machine, with housewares retaining second place as a use for new equipment. New thermoforming machines went mainly

Table VI: Operable Machines in the United States

	1944	1947	1950	1953	1956	1958	1959	1960
INJECTION MOLDING MACHINES								
Year end cumulative machines sold	1410	3395	5272	7570	10479	12474	13726	14820
Machines 12 years old or older	—	—	—	1000	1410	3075	3395	3873
Operable machines	1410	3395	5272	6570	9069	9309	10331	10947
SCREW EXTRUDERS								
Year end cumulative machines sold	650	1269	2164	3553	5591	7154	8238	9504
Machines 10 years old or older	—	—	—	—	1107	1556	1900	2164
Operable machines	650	1269	2164	3553	4484	5598	6338	7340
SHEET THERMOFORMING MACHINES								
Year end cumulative machines shipped	—	—	—	—	970	1618	2107	2694
BLOW MOLDING MACHINES								
Year end cumulative machines shipped	—	—	—	—	—	16	86	148

into the production of refrigerator and air-conditioning parts, novelties, and displays in 1959. In 1960, the major uses for new machines appear to be in the packaging and display fields. Compression presses continue to be purchased for their traditional use in the production of industrial product components.

When it comes to improved machine features, injection molders still are looking for faster cycles, greater plasticating capacity, and faster mold-filling features. Extruders in 1959 wanted higher power and higher output rates; along with these, in 1960, they sought designs with easier maintenance requirements. Thermoformers still clamor for automation, faster speeds, and quicker heating systems. The same features, automation and higher speed, are also the desire of users of compression presses and blow molding machines.

Export

Generally speaking, competition from foreign equipment manufacturers did not seem to be a problem for American machine manufacturers in 1960.

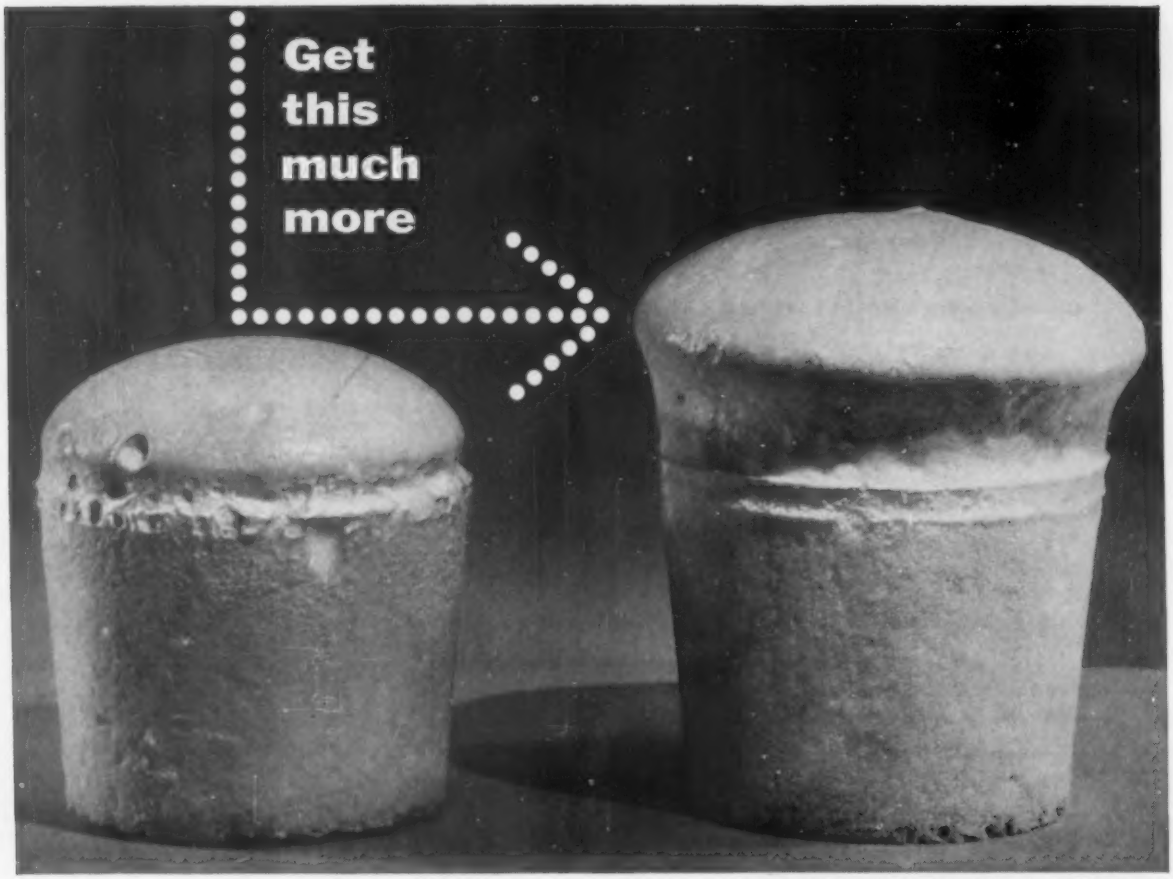
With the exception of thermoforming machines, 1960 sales increased over 1959 for all types of plastic processing equipment covered in the survey. This is in direct contrast to last year's sales and may indicate that, with increasing affluence and ability to purchase abroad, foreign users still prefer American equipment when they can afford it. However, definite answers to the fluctuation in export sales of machinery in the last few years are hard to pin down.

Sources of data

To obtain the data shown in the accompanying tables, questionnaires were sent to all known manufacturers of processing equipment. Each was asked to list the actual sales made in 1959 and furnish an estimate of 1960 sales. The 1959 sales were used to check and correct figures of prior years; the 1960 estimates were totalled as received. The past few years' experience has demonstrated that no further accuracy would be gained by our applying a correction factor of our own, since changes or inaccuracies in figures submitted in successive years do not follow a consistent pattern of deviation.

Summary

Although 1960 was not a banner year for the sale of plastic machinery, sales in most categories did increase. Furthermore, estimates indicate an overall increase in the number of operable machines in the field and, hence, an increase in the capacity of the industry to process increasing amounts of plastics materials. Considering the overall business picture of the past year, it would appear that the plastics industry has at least kept pace with other industries—and is probably still growing at a faster rate than most. Latest reports indicate that machinery sales are looking up for 1961, and it seems reasonably safe to conclude that the industry in general can look forward to more vigorous growth in the coming year.—*End*



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1960 Engineering Highlights

Brief reviews of important advances in plastics engineering during the past year

With a few notable exceptions, the year 1960 was not characterized in the literature as a year of radical innovations in plastics engineering technology. However, the articles appearing did indicate a more searching approach to the solution of existing problems and the improvement of older techniques. Also evident was the rapid growth of the use of plastics in an ever broadening variety of applications. In some fields such as sheet forming, blow molding, and compression molding, because of the field's youth or age, technical articles were hard to find. Obviously, all the fine articles on various subjects appearing during the year could not be included in this review. The basis for selecting the articles summarized below was our opinion on the novelty, depth of coverage, and the contribution made to the constantly increasing fund of plastics technology.

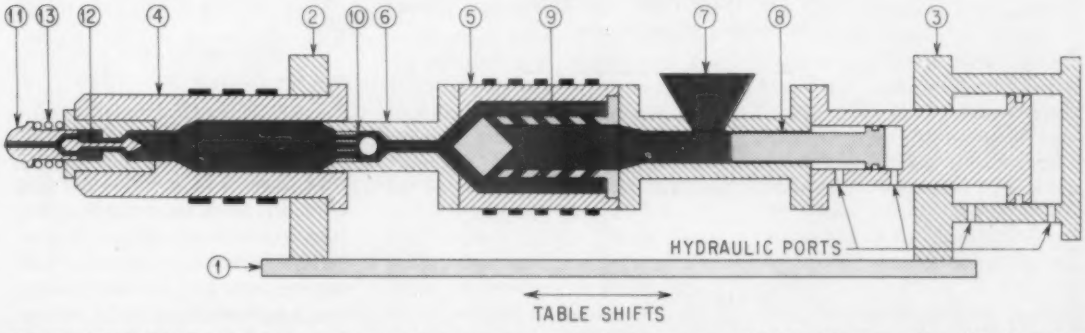
The references presented here were prepared from articles appearing in some 30 domestic and foreign periodicals in the plastics and allied fields. Books pertinent to the same topics and published during 1960 have been reviewed currently during the year and are not included in this selected roundup. Articles on Technical Section subjects (such as materials, testing and chemistry), unless they relate directly to plastics processing or applications, are also omitted. Interested engineers will find brief comments on such articles in "The Year 1960 in Review," p. 141.

Injection molding

Nothing radically new in 1960, in the sense that developments being written about were available, if not widely used, prior to this year. Typical of these developments is the reciprocating-screw injection machine which is receiving a close evaluation in the U. S. In a reciprocating-screw machine, material is plasticated by means of a revolving extrusion screw in the heating cylinder of the machine. For injection the screw moves forward on its axis and acts as the ram. Biggest advantage is in the thorough plastication of the melt which results in moldings with less internal stress and better uniformity. For a review of the principles of these machines and a comparison with conventional piston machines, see *"New approach to the injection molding of thermoplastics,"* by H. Beck, *Der Plastverarbeiter 11,* 441 (Oct. 1960), In German; and *"Reciprocating screw injection machine."* by J. G. Fuller, *MPI 37,* 110 (April 1960).

Another preplasticating injection machine (See below), is reported in *"Melt extractor moves into new role—preplastication,"* by A. Spaak, *MPI 38,* 107 (Oct. 1960). In this machine preplastication is accomplished by a stuffing piston, which forces material through a preplastication chamber fitted with a melt extractor torpedo. The front end of the preplasticating cylinder also acts as the injection ram. Material passes through this ram into the shooting cylinder and thence into the mold. Design allows the placement of the preplasticating and shooting cylinders on the same axis and results in an injection unit which can be mounted on existing machines. Major advantages claimed are increased plasticating capacity and more uniformly plasticated melt. Another machine, very similar in design is described in *"Autopreplastification—New concept in injection molding,"* by H. Prus, *Industrie des Plast. Modernes 11,* 57 (Nov. 1959). In French. The system uses twin preplasticating cylinders instead of the melt extractor in a single cylinder.

Also noteworthy is an evaluation of the possible use of new heating methods for injection machines, presented in *"Induction heating for injection molding machines,"* *Brit. Plastics 33,* 380 (Aug. 1960). Resistance heaters are lower in cost; however, they do have a limited operating life. Excluding mechanical damage, induction heaters should last as long as the molding



SCHEMATIC DIAGRAM of Maccaferri melt extractor preplastication system. (1) Movable base plate, (2), (3) injection system support blocks, (4) fixed accumulator injection cylinder, (5) movable preplasticating cylinder, (6) injection piston, (7) feed Hopper, (8) preplasticator stuffing piston, (9) melt extractor, (10) ball check valve, (11) injection nozzle, (12) nozzle valve, (13) spring.

machine itself. It is believed that the advantages of induction heating in injection molding should be greater than those for extrusion.

Also on the heating of injection machines is "Heat balance in an injection molding machine," by H. Hofmeister and W. Knappe, *Kunststoffe 50,* 541 (Oct. 1960) In German. Results obtained in this study indicate that the use of glass wool insulation on the heating cylinder reduces heat loss by more than 40%, reduces heat-up time, and provides more uniform cylinder temperatures for molding.

Noteworthy for completeness and detailed specifications are the run-down on injection molding machine data in *Modern Plastics Encyclopedia Issue for 1961* (p. 935) and the article, *"Injection machines of the world," Brit. Plastics 33,* 285 (July 1960).

Turning to the operation of the process itself, it is reported that shrinkage and voids in sharply melting polymers (such as nylon) having a large volume change on solidification, require that additional melt be forced into the cavity as the parts cool. Other polymers, such as styrene, which undergo only a small volume change, must be injected with an initially high pressure to guarantee enough melt in the cavity to avoid sink marks and voids. For complete discussion, see *"Overcoming shrinkage and voids in thick-section moldings,"* by K. R. Lawrence and P. B. Wright, *Brit. Plastics 33,* 66 (Feb. 1960).

Some good papers on orientation in injection moldings appeared during 1960. In *"Orientation in injection molding"* (See graph, below), by R. L. Ballman and H. L. Toor, *MPI 38,* 113 (Oct. 1960), it was concluded that gate, cavity dimensions, and other process variables act as controlling factors in determining the net orientation in a molded piece. Article explains how these factors interact to increase or decrease orientation as measured by birefringence techniques. A related paper shows how orientation affects the properties of the molded pieces. See *"The effect of orientation on the physical properties of injection moldings,"* by G. B. Jackson and R. L. Ballman, *SPE J. 16,* 1147 (Oct. 1960).

For a theoretical discussion of orientation and its effects, see *"Effect of orientation on the strength of a model solid,"* by A. Robinson, J. E. Osborn, and C. C. Hsiao, *J. Appl. Phys. 31,* 1602 (Sept. 1960). Using a hypothetical model of a polymer solid, equations are developed for the calculation of the failure stress of a fully oriented polymer as a function of the orientation strain. Predicted failure stress for a fully oriented polymer is six times that of a random polymer. Experimental data shown for uniaxially oriented polyethylene agree closely with calculated values.

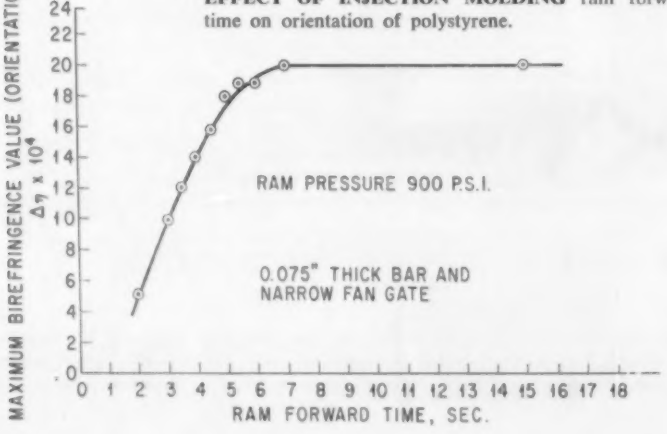
Evidence is presented in *"Melt flow of linear polyethylene,"* by A. P. Metzger and C. W. Hamilton, *Rubber Age 87,* 635 (July 1960), to the effect that melt index is not indicative of how polymer will flow into a cavity and confirms the need for a better test parameter.

Noteworthy, because it presents processing know-how on a new material, is *"How molding conditions affect polypropylene,"* by H. Robb, *MPI 38,* 116 (Nov. 1960). It is reported that the degree of isotacticity and molecular weight distribution play a larger role in determining the properties of molded parts than do molding conditions, assuming the molding conditions are such to produce an uniform homogeneous melt. Another good paper on the same subject is *"Physical properties and injection molding technology of polypropylene,"* by D. Schleede and F. Schulder, *Der Plastverarbeiter,* Part I, *11,* 130 (March 1960), and Part II *11,* 161 (April 1960). In German. The latter article is loaded with a wealth of graphical data on properties and their variability with processing conditions.

On the subject of linear polyethylene, *"The injection molding of high-density polyethylene,"* by D. G. Briers and D. Burgess, *Brit. Plastics 33,* 100 (March 1960), deals with mold design and emphasizes the need for fast filling of the mold, provisions for uniform mold-temperature control, and the careful location of ejector pins so as not to distort the piece on ejection. It also discusses the use of molding conditions to achieve satisfactory results. More on the same subject will be found in *"Characterization properties of polyolefin injection molding compounds,"* by M. Vlig and K. W. R. Wilson, *Kunststoffe 49,* 659 (Nov. 1959). In German.

The molding behavior of polycarbonate materials is discussed in *"Experiments on the injection molding of Makrolon,"* by W. Backofen, *Kunststoffe 49,* 664 (Nov. 1959). In German. As pointed out in this discussion, gating and mold temperature are important; it is also important that mold temperature should not fall below a minimum of 85° C.

In *"Dry-tumbled blends of high- and low-pressure polyethylene,"* by J. B. Wolheim, *Plastics Tech. 5,* 35 (Nov. 1959), molding powders of 0.91 and 0.96 density polyethylenes were blended by injection molding after dry tumbling, using a multihole venturi breaker plate. A number of low-density resins with M.I.s ranging from 2 to 22 were blended with a high-density material with an M.I. of 5.4 at four different levels of composition. Elastic modulus, melt index, spiral flow, density, and boiling water resistance varied fairly


MAXIMUM BIREFRINGENCE VALUE (ORIENTATION), Δη x 10⁴
0 2 4 6 8 10 12 14 16 18 20 22 24
RAM PRESSURE 900 P.S.I.
0.075" THICK BAR AND NARROW FAN GATE
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
RAM FORWARD TIME, SEC.

EFFECT OF INJECTION MOLDING ram forward time on orientation of polystyrene.

regularly according to the composition of the mix.

Of interest to injection mold designers is *"An analysis of injection mold filling of polyethylene,"* by R. B. Staube, *SPE J. 16,* 429 (April 1960). This paper discusses how the polymer melt flows into a cavity, as well as how process variables can affect this flow pattern.

Also for mold designers, as well as molders, is *"Multiple-level injection molding,"* by E. J. Csaszar and T. Saulino, *SPE J. 16,* 1009 (Sept. 1960). This describes a mold construction technique in which cavity plates are stacked in tandem, allowing fuller utilization of the plasticating capacity of an injection molding machine without exceeding the clamp capacity. Although not applicable to all jobs, it can sometimes be used to cut machine cost per part. Still on mold design, *"Multigating techniques for high-density polyethylene,"* by C. L. Weir, *Plastics Tech. 6,* 43 (May 1960), presents a review of the applicability of various gating designs for molds to be used with high-density polyethylene. Balanced filling of all cavities and almost instantaneous fill are required for optimum results. *"Mold design for improved cycling,"* by J. W. Mighton, L. W. Meyer, and R. L. Bersley, *SPE J. 16,* 183 (Feb. 1960), discusses six new mold construction ideas aimed at faster cycles. Three hot-nozzle techniques and three mold-chilling concepts are included in the article. Among these are the use of brazing to construct mold coring for cavities too complex for drilling, internal nozzle heaters, and high-conductivity metal rods that are used for mold cooling.

A review article on the state of the art of injection molding auxiliaries is *"Matching injection molding equipment," Plastics Tech. 6,* 56 (May 1960). The subtitle of this article accurately gives its content: "How auxiliary equipment can be engineered to provide optimum performance and economy." The paper brings the molder's attention to all those considerations, big and little, that he should think about before dashing out to buy temperature controls, mold chillers, grinders, and other paraphernalia.

Also concerned with economics is *"To mold or to machine, that is the question,"* by G. C. Carlyon, *MPI 38,* 90 (Oct. 1960). There is always a break-even point between the two methods, depending on part complexity and the quantity of parts required. Five parts are used as examples to show how variable this break-even point can be.

Compression molding

In contrast to blow molding, articles on the very mature process of compression molding appearing in 1960 were almost wholly devoted to operating details and tests. Advances in this technology consist of sharper interpretations of processing conditions using advanced methods. A case in point is *"Evaluating plastics for compression molding of phonograph records,"* by W. E. Coleman, *Plastics Tech. 5,* 47 (Dec. 1959). It is reported that extrusion-rheometer data in the low shear range can be used to estimate the molding performance of vinyl and styrene record compounds. The author makes use of a power relationship between platen separation and press-closing time and concludes that optimum recording behavior is obtained when the molding compound has an apparent viscosity of from 1.2 to 1.7 lb.-sec./sq. inch.

Another test method useful in molding phenolic compounds was described in *"A simple and accurate method for controlling preform hardness,"* by E. W. Vaill, *SPE J. 16,* 413 (April 1960). Using the Durometer on the "D" scale, the hardness of preheated phenolic preforms is measured and used as a quality control parameter in the compression molding of the material. A third paper dealing with the processing properties of materials and their effect on compression molding was *"Cure of molded melamine resin and its significance for properties,"* by H. P. Wohnsiedler and R. A. Tiley, *SPE J. 16,* 299 (March 1960). Well illustrated, this article discusses the effects of cure on shrinkage, electrical properties, impact strength, flexural strength, and other properties of melamine resins. Design is also found to be a factor and its effect is demonstrated by experiments run on three coffee cups of differing design.

A very good discussion of shrinkage will be found in *"How close your tolerances?"* by P. E. Fina, *Plastics Tech. 6,* 48 (Oct. 1960). Often many potential applications are never developed because of the fact that molders reject tolerances believed impossible to work with. This discussion points up the factors affecting shrinkage and tolerances and how these factors can sometimes be controlled to meet tight requirements.

Blow molding

Although sales of blow-molding machines proceeded at a merry rate and a vast array of new blow-molded products were in evidence during 1960, the technical literature impressed us as being more of the same. That is to say, many of the articles appeared to be written for the novice in the audience. Subject matter tended towards explanations of what blow molding is and the different types of machines available. Perhaps this is only natural in view of the only recent commercial exploitation of the process and the tendency to keep the technical details as "trade secrets."

For well written round-ups on the various processes available and what types of equipment are required, see *"Blow molding—How to get into it, What you can get out of it," MPI 37,* 96 (Dec. 1959) and *"Blow molding I—Fundamentals"* by I. Thomas and N. F. Harwood, *Plastics Tech. 6,* 31 (July 1960), and *"Blow molding II—role of the extruder,"* by A. A. Kaufman and I. Thomas, *Plastics Tech. 6,* 36 (Oct. 1960).

Other articles on blow molding dealt with handling of specific materials. *"Extrusion blow-molding techniques for high-density polyolefins,"* by R. Doyle, D. E. Perry, and T. E. Branscum, *SPE J 16,* 609 (June 1960), described the production of high-density PE bottles, recommending equipment and discussing the effects of the processing conditions on the product. *"The blow molding of cellulosic plastics,"* by D. A. Jones and R. J. Haughwout, *SPE J. 16,* 633 (June 1960), presented a *(To page 128)*

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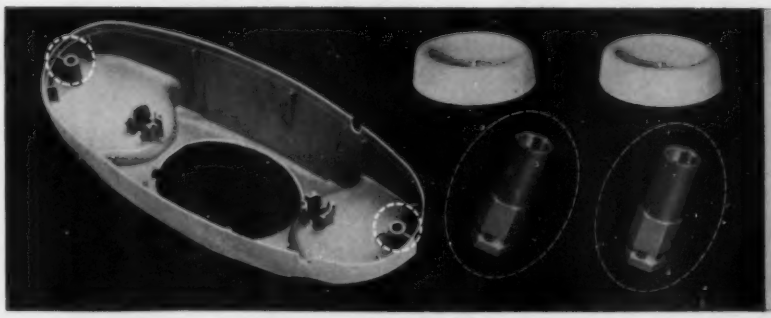
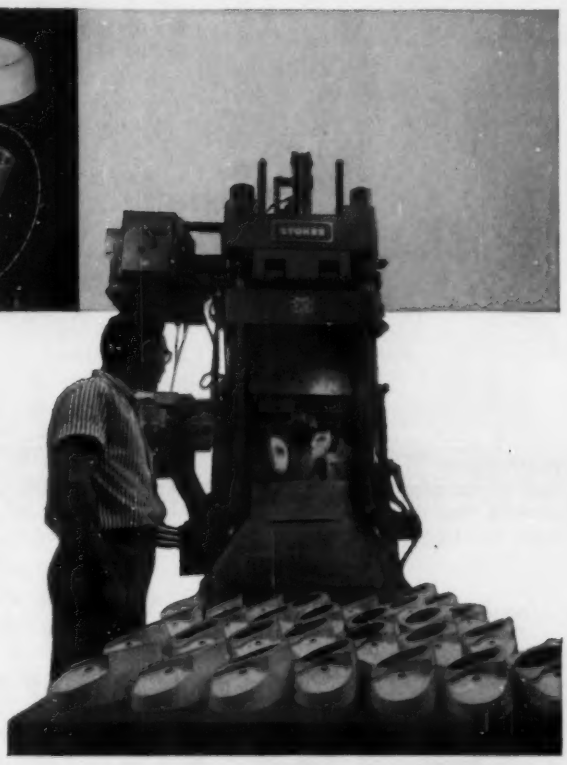


The photo above shows the location of the metal inserts in the bottom of the housing. The transmitter and receiver caps shown here were also produced automatically. Unscrewing, degating, and separating of molded caps and runner systems are all accomplished with one operator attending several machines.



More than 20 motions and checking devices are incorporated in the Stokes 703 press. Metal inserts are bulk loaded, correctly oriented and metered to the loader. An automatic escapement device releases the inserts into a loading tray where they are checked. If the inserts are correctly positioned, the tray moves into the die area to drop the inserts into the mold. After the positioning of the inserts is again checked, the loading tray is retracted and the automatic injection molding cycle started.

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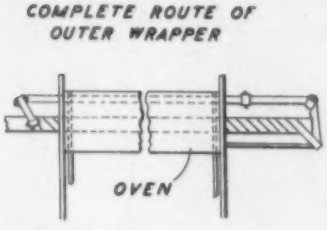
discussion of the properties of cellulose acetate and propionate as they relate to the use of these materials for bottles. Also included are processing conditions for these plastics and equipment considerations.

Reinforced plastics

Increasing interest in spray-up techniques, filament winding, and the development of other novel methods of handling fibrous glass reinforced plastic systems was the order of the day in 1960. Also evident was the growing number of investigations into the properties of the raw materials in such systems and their effects on the properties of the final structure.

A novel new way to make continuous lengths of glass-reinforced pipe was described in *"How to make continuous RP pipe,"* by D. Henis, *MPI 38*, 119 (Sept. 1960). An ingenious machine was developed (See diagrams, below), which uses "collapsing" stainless steel mandrels. Pre-preg tapes are the starting material. These are wound over a helically wound stainless tape and then overwound with another stainless tape prior to oven curing. After curing, the stainless tapes are stripped from the inside and outside of the pipe and "recycled," the cured pipe emerging free of mandrels from the machine.



SCHEMATIC of oven section of the pipe machine, showing the path of the outer steel tape mandrel.

Closely allied to this method of forming a reinforced structure is the process of filament winding. Here either precoated filaments are wound on the shape to be made or are wound dry and impregnated with resin after winding. For excellent across-the-board reports, see *"Filament winding—some basic principles of the process,"* by Kenneth B. Turner, *MPI 37*, 116 (Dec. 1959), and *"Filament-wound reinforced plastics: state of the art,"* by M. W. Riley, J. H. Lieb, E. H. Jaffe, S. A. Miller, and J. S. Carter, *Mat'ls in Design Eng. 52*, 127 (Aug. 1960).

Another useful processing technique is described in *"Sandwich without a core," MPI 37*, 92 (Feb. 1960). Aircraft engineers interested in producing hollow-walled radomes developed a "lost wax" method of molding inner and outer shells with built-in air ducts. Warm air is circulated through the hollow wall to keep ice from forming on the radome in flight. Other designers interested in using reinforced plastics in their products will find a valuable reference in the article *"Which process for Fiberglass-reinforced plastic molded parts?"* by G. S. McElroy, *Prod. Eng. 31*, 47 (Jan. 11, 1960), which provides an excellent roundup on what makes one molding process different from another. Written for the designer who wants to know what factors he should consider in specifying fibrous glass-filled plastics, this paper presents concise descriptions of the methods, terms, relative merits and production costs that are associated with 15 different types of processes.

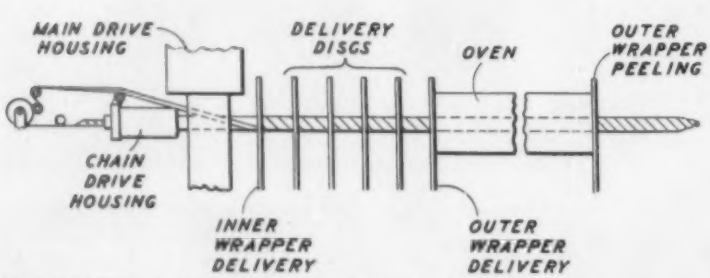
One of these RP molding methods is described in more detail in *"Air preforming with matched metal dies,"* by M. Martin, *Prod. Eng. 31*, 74 (March 28, 1960). Claimed to be the most economical method yet developed for molding high-strength parts in large volume production, the process is thoroughly explained and related to design in this particular article.

One of the most significant trends in reinforced plastics processing is based on the spray-up method. Coming on the market in increasing numbers are portable spray-up units which can be used in the field for *in situ* erection of reinforced plastic structures. A case history of this technique, showing how it can be used for the erection of small buildings, is presented in *"Field erection of plastic shelters,"* by A. F. Gurdo, J. M. Schramp, J. E. McCormick, and G. J. Stabler, *MPI 37*, 113 (Aug. 1960). Paper explains the use of Mylar film molds, presents a list of equipment and materials required, and explains the methods used in construction of the molds.

Also being developed for the spray-up process are new materials. *"Glass flakes: key to new, strong coating," Chem. Eng. 67*, 162 (Sept. 5, 1960), describes a new spray-up material consisting of flakes of borosilicate glass about 0.00008-in. thick and pre-coated with resin. Advantages are ability to lay up thick coatings and elimination of the need for glass fiber chopping mechanisms on the spray gun. Major use is expected to be for corrosion-resistant coatings on large chemical tanks.

Several papers of note report on the importance of selecting the proper formulation. *"Heavily stressed light construction parts of glass fiber-reinforced plastics,"* by U. Hutter, *Kunststoffe 50*, 318 (June 1960), reports that rigidity, tensile strength, and toughness of fibrous glass-reinforced laminates increase with an increasing volume or weight of glass in the composition. Increasing the glass content above 80% is complicated by the viscosity of the resin impregnants which interferes with the ability to squeeze out excess resin. Methods of increasing glass content are discussed and the article further explains how laminates with 85% glass can be prepared.

The quality of the glass fiber is



SCHEMATIC of pipe machine showing path of the inner steel tape mandrel.

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also reported to be a crucial variable in the strength of plastic laminates. The effect of the glass fiber on the laminate is discussed in *"Defects in glass fibers and their effect on the strength of plastic moldings,"* by N. J. Parrat, *Rubber and Plastics Age 41*, 263 (March 1960). Failure to develop the full theoretical strength of a bundle of glass fibers is said to be due to the fact that they are not equally loaded in a laminate under stress. Therefore, the sum of the strengths of fibers in a bundle is not realized in randomly distributed as well as kinked fibers.

The factors above have given rise to the use of preshaped glass fabrics in the manufacture of laminates. Such glass fabrics are discussed in *"Contour weaving,"* by A. R. Campman, *Prod. Eng. 31*, 47 (March 21, 1960). Described is the use of fibrous glass preforms woven into the shape of the part to be produced. Major advantage is the ability to obtain more uniform wall thickness and better fiber distribution in complex and irregularly shaped objects.

A theoretical approach to the prediction of properties of reinforced plastics dependent on the orientation of the glass fibers in the plastic is presented in *"How to predict structural behavior of RP laminates,"* by L. Fischer, *MPI 37*, 120 (June 1960). A rigorous mathematical analysis of fibrous glass laminates is presented. Excellent agreement is found between curves based on calculated relationships and experimental results and the developed equations may be used for estimating ultimate stress values for laminates.

Advances in resin formulation are also leading to the development of better reinforced products. It is reported that an equimolar ratio of isophthalic and maleic anhydrides is not as good as a mixture of one mole of isophthalic with two moles of maleic for the development of resins which will retain their strength properties at temperatures above 260° F. For further details, see *"High-temperature properties of isophthalic polyester resins,"* by C. B. Perizzolo, *Plastica 12*, 924 (Dec. 1959). In Dutch.

It is also reported that formulation, as well as weight of veil mat, concentration of pigment, and especially variations in the filler content will affect the final color of a reinforced plastic part. Catalyst content, cycle, and molding temperature were found to have little effect on color, but techniques used to mix the formulation were crucial. See *"The effect of molding conditions on the color of reinforced plastic moldings,"* by T. H. Beals, *Plastics Technology 6*, 51, (Oct. 1960).

Extrusion

One of the most significant advances in the extrusion field was the development of equipment which allows the application of a vacuum to the feed hopper of the process. Feeding powders and pellets under a vacuum removes occluded air from the feed and significantly reduces the porosity of the extrusion, as well as improving the surface of the extrudate issuing from the die. Feeding under a vacuum also helps to remove surface moisture. Full details on the particular process were published in the article, *"Vacuum hopper extrusion,"* by N. T. Flathers, R. E. Johnson, V. R. Pallas and W. M. Smith, *Modern Plastics 37*, 105 (April 1960).

Progress was also reported on the extrusion of vinyl compounds using liquid plastisol as the feed. As the liquid plastisol passes through the extruder, it gels under heat and a fully plasticated compounded melt issues from the extrusion die. In the past, the gelling of the plastisol was often uncontrollable, leading to erratic extrusion operation. Using positive-pressure pump feeding eliminates this problem. The technique is described in *"How to extrude plastisols,"* by C. H. Brower and B. H. Maddock, *MPI, 38*, 127 (Oct. 1960).

Another report on the off-beat use of the extrusion process to make polystyrene foams points out that many variables affect the production of extruded foams of polystyrene. Lowest-density foams are best made at relatively low extrusion temperatures with expansion taking place after the material leaves the die. Production of high-density foams is somewhat more complex and harder to control. See *"Controlled-density polystyrene foam,"* by F. H. Collins, *SPE J. 16*, 705 (July 1960).

A neat trick for improving the clarity of blown film was reported in some detail in *"High-clarity blown film,"* by J. Pilaro and R. Kremer *MPI 37*, 115 (June 1960). The paper describes the use of an annealing chamber, or chimney, above the exit of the tubular film die. The annealing taking place in the chamber depends on its height and generally improves the gloss and clarity of the blown film.

For a good roundup on the extrusion of polyethylene pipe, see *"New developments in the fabrication of plastic tubing,"* by M. Dominghaus and H. O. Schiedrum, *Indust. des Plast. Modernes 12*, 18 (May 1960). In French. Included is an excellently illustrated discussion on sizing and pipe calibrating devices and a brief description of the biaxial pipe orientation process.

More information of the extrusion of polyethylene will be found in *"Thermal and shear degradation in polyethylene extrusion,"* by H. Schott and W. S. Kaghan, *MPI 37*, 116 (March 1960). Presented is evidence for the very significant conclusion that polyethylene is not degraded by repeated extrusions provided that severe thermal exposure is avoided. This means that scrap from extrusion processes where temperatures are not high enough to cause degradation can be safely reused to produce a number of quality products.

Further studies on the behavior of polyethylene in extrusion are described in *"Flow of polyethylene into a capillary,"* by E. B. Bagley and A. M. Birks, *J. Appl. Physics 31*, 556 (March 1960). Experiments in a quartz-walled capillary viscometer are presented in the form of excellent photographs of the flow patterns in the polyethylene upstream from the die exit. The results of these studies confirm prior studies made on the melt fracture occurring in polyethylene melts.

For the exruder who wants to know more about what screw to use for what job, there is the meaty article, *"Feedscrew selection,"* by J. Badonsky *SPE J. 16*, 171 (Feb. 1960). This article contains a list of the variables to consider when designing and specifying extruder screws. Included is a sample problem in polyethylene illustrating the

use of a checklist to point the way to proper screw design. A complementary paper on the subject of screw design is *"Pressure development in extruder screws,"* by B. H. Maddock, *SPE J. 16,* 373 (April 1960). A study of pressure profiles was made along the barrel of an extruder using various types of screws. It was concluded that metering sections longer than those currently in use should be employed to achieve improved quality when operating at high production rates.

The control of the pressure developed by the screw is now recognized as a must for good extrusion results. Some machines have valves to control the pressure. If you have an extruder without a valve, see *"Fixed orifice pressure control for extruders,"* by B. H. Maddock, *Plastics Tech. 6,* 41 (Sept. 1960). The paper explains how to select the type of pressure control needed for an extruder using fixed orifice plates. It describes the calculations required and presents experimental evidence to prove the validity of the estimation methods.

In the measurement of extrusion pressures and temperatures, new devices are providing a more sophisticated approach to the problem of extruder instrumentation. Pressure transducers and thermistors are found to have more rapid response in the measurement and recording of extruder pressures and temperatures than do Bourdon gages and thermocouples. As new tools for extrusion variables, they will find use in the future. See *"Extruder instrumentation,"* by H. B. Kessler, R. N. Bonner, P. H. Squires and C. F. W. Wolf, *SPE J. 16,* 267 (March 1960).

Newer methods of heating may also help to advance extrusion technology. For example, induction heating reduces warm-up time, decreases response time, increases heater life, allows for better barrel temperature indication, and facilitates cooling since air can be circulated between coils and the barrel and impinges directly on the hot barrel. With better cooling it is reported higher screw speeds are possible. For the full discussion, see *"Induction heating and high screw speeds in extruder design,"* by A. Lord, *Rubber and Plastics Age 40,* 1287 (Dec. 1959).

Among the interesting miscellaneous developments is a unique screw design used in the Werner and Pfleiderer ZSK 83/700 twin-screw compounding extruder. The screw sections are constructed using annular segments assembled on a keyed shaft. Differently shaped segments can be arranged and rearranged to alter feed and metering zones along the length of the screw. Also incorporated are non-helical meshing segments which act as a kneading machine in one section of the screw. The machine is also suitable for devolatilizing compounds through vented ports. For a full description of this offbeat design, see *"Twin-screw devolatilizing dispersion extruder," Rubber and Plastics Age 40,* 1291 (Dec. 1959).

In the past it was necessary to remelt and repelletize film scrap using an extruder and a cutter in order to densify the material for reuse in extruders; the poor feeding qualities of the bulky scrap made this a necessity. Now a process, originally designed for pelletizing animal feeds, is being used to make compacted pellets directly from the scrap. The film is shredded and cold extruded through openings in a circular mulling drum. Pressure and friction developed in forcing the material through small holes produces pellets resembling hot compounded pellets but slightly bulkier. For details see *"Polyethylene film scrap a problem? Try this,"* by G. Bamberger, *MPI 37,* 114 (April 1960).

Sheet forming

For an up-to-date status report on sheet forming, see *"Giant thermoformed parts," MPI 38,* 91 (Sept. 1960). Included is a discussion of the advances in technology and a review of the variables of heating (heating from both sides has replaced one-side heating), cooling (combinations of air and liquid coolants are the trend), forming techniques (simple vacuum and drape methods have been found inadequate), gage uniformity (sheet thickness must not vary), and warpage (proper and even cooling and molding techniques are the key). As the article also points out, thermoforming is moving ahead without ballyhoo, which is confirmed by our review. Only two other articles of any depth were found in the periodicals surveyed. In addition, these deal only with the forming of specific materials. One is concerned with *"Designing thermoforming molds for linear polyethylene,"* by R. Doyle and D. E. Allison, *SPE J. 16,* 263 (March 1960), and covers materials of construction, mold channeling, exterior contouring, surface finish, male vs. female molds, and mold shrinkage compensation. Excellent drawings illustrate key design details.

The other article noted was on *"Vacuum forming of polycarbonate films,"* by W. Neitzert, *Der Plastverarbeiter, 11,* 261 (June 1960). It was found that polycarbonate sheet is easily formed using a sheet temperature of 180° C. and a mold temperature of 115° C. Article discusses other processing conditions and also includes information on pressure forming. Sheet should be perfectly dry when formed.

Some new techniques

Last year saw the introduction of a new process for the production of large polyethylene items. Called the Engel process after its originator, Thomas Engel of Germany, it is tradenamed "thermofusion" by Spencer Chemical Co., which holds U.S. rights to this process. In operation, the process requires a feed of finely powdered polyethylene, which is loaded into low-cost sheet metal molds. The packed mold is then placed in an oven which causes the powdered material adjacent to the walls of the mold to fuse or sinter. After the prescribed time for a given depth of fusion, the mold is removed, the excess of unfused material in the center of the mold is poured out, and the mold with its polyethylene coating is replaced in the oven for completion of the fusion process. Typical potential products are such things as boats, tanks, and drums. More details will be found in *"Large-size objects with low-cost tooling," MPI 37,* 86 (March 1960).

A first cousin of the Engel, or "thermofusion," process, what one

might call inside-out thermofusion or fluidized bed coating, is also attracting widespread interest and also requires a powdered plastic feed. Good reading for those desiring to know more about this process is *"Some fundamental aspects of fluidized bed coating,"* by J. Gaynor, *SPE J. 15,* 1059 (Dec. 1959). The paper presents an excellent discussion in depth of fluidized bed process variables. It also evaluates the not-too-often discussed hazard of handling flammable plastic powders. Another basic article is *"Fluidized bed: heavy coatings in one dip,"* by W. R. Pascoe, *Mat'ls in Design Eng. 51,* 91 (Feb. 1960). Included is a table of the temperatures to which parts to be coated must be heated prior to immersion in the fluidized bed of plastic. Pre-heat temperatures for six plastics are given. The properties of the coatings—cellulosics, vinyl, epoxy, nylon, PE, and chlorinated polyether—are discussed.

Another variation in coating techniques is comprehensively covered in *"Dip coating with thermoplastics," Brit. Plastics 33,* 16 (Jan. 1960). The article is a thorough survey of the materials and techniques used for coating parts with plastic. Principal advances have consisted of improving the adhesion of the coatings to the parts. Part design and proper surface preparation are the important factors in getting good dip coatings. Article also discusses the commercial equipment being used.

Coating processes are also the subject of *"PVC-coated metal combinations,"* by S. Pezarro, *Plastica 13,* 453, (June 1960), which summarizes the various processes available (with flow sheets) for the application of PVC coatings to metallic sub-strata.

The adhesion of PVC coatings to fabrics is discussed in *"Polyvinyl chloride adhesion to synthetic fabric,"* by C. F. Blaich Jr. and A. J. Simpson, *SPE J. 16,* 206 (Feb. 1960). It was found that the use of dianisidine diisocyanate as a cross-linker in conjunction with terpolymers based on vinyl acetate, vinyl chloride, and maleic anhydride results in coatings with exceptional adhesion when bonding vinyl film to or coating plastisols on synthetic fabric.

For processors calendering vinyl sheet, *"Rheological study of vinyl calendering compounds,"* by W. E. Wolstenholme and P. E. Roggi, *MPI 37,* 131 (March 1960), contains much of interest. (See table, above). The rheological properties of vinyl chloride compounds can be predicted from molecular weight of the resin, processing temperature, and plasticizer content. Results are used to determine optimum calendering conditions.

Optimum calendering temperature vs. viscometer equilibrium reading (R_e) for vinyl compounds

Marvinol[a] *resin*	*Specific viscosity*	*Plasticizer (Parts DOP)*	*Optimum calendering temperature*	*Calculated* R_e
MX-2103	0.50	50	324	28.6
VR-31	0.44	50	315	28.9
VR-33	0.37	50	305	27.2
MX-2102	0.31	50	295	25.4
			Average	27.7

[a] Registered trademark of United States Rubber Co.

More on selecting the proper resin, stabilizer, lubricant, and pigments for calendered rigid vinyl sheet will be found in *"Compounding and processing rigid vinyl sheets,"* by R. C. Rumberger, *SPE J. 16,* 87 (Jan. 1960). This paper contains valuable suggestions which can be used to avoid pitfalls in setting up a calendering line for rigid sheet. Another short article with tips on the processing of vinyl films follows in the same journal: *"Calendering vinyl film,"* by R. A. Mansfield, *SPE J. 16,* 89 (Jan. 1960).

One novel method for the processing of multi-component epoxy resin systems was reported in 1960. The report, *"Epoxy parts cast by centrifugal force,"* by R. Buenger, *Prod. Eng. 31,* 45 (May 23, 1960), describes the use of cast epoxy molds and a simple centrifuge to cast centrifugally epoxy parts without expensive tooling or molding equipment. Included are mold-making techniques and the production details. Method is an ingenious solution to the problem of making short-run parts economically.

On epoxy resin processing in general, engineers will find most helpful the paper *"The measurement of exotherm characteristics and their application in epoxide resin casting systems,"* by G. R. Edwards, *Brit. Plastics 33,* 203 (May 1960). A new technique of expressing the reactivity of casting resins with amine curing agents is explained. Compared with the usual gel-time measurements, the new method has the advantages of being based on fundamental system properties and being easy to use. Called "the effective reactivity curve," it can be used to predict the curing behavior of casting systems under a wide range of variable conditions.

Also appearing in increasing numbers in the literature on processing are papers on the biaxial orientation of plastics materials. The beneficial effects of biaxial orientation on the properties of plastics is creating considerable interest in the technique. Formerly only used for the production of sheet materials, the method is put to good use in the production of thermoplastic pipe. Such a process, recently developed in Europe, is described in *"Why biaxially oriented pipe?"* by W. E. Gloor, *MPI 38,* 111 (Nov. 1960). It is reported that stretching high-density polyethylene pipe simultaneously in two directions at about 120° C. improves the rupture strength of the pipe. Net result: ability to use thinner-wall pipes for same service requiring heavy-wall conventional pipe. Article describes equipment in some detail.

Another report discloses that biaxial orientation of acrylic sheet improves its craze resistance. However, the stretched sheet is estimated to cost about three times more than an unstretched sheet of the same thickness. For further

details see *"Biaxially stretched acrylic sheet,"* by J. W. Ladbury, *The Plastics Inst. Trans. and Journ. 28,* 184 (Oct. 1960).

New techniques of handling expandable polystyrene foam are explained in *"Three new techniques for processing expandable styrene foam," MPI 38,* 113 (Sept. 1960). Techniques outlined are extrusion, dielectric expansion, and injection molding. Three-part article treats each as an entity and discusses the variables involved and the status of each method.

In the processing of rigid urethane foams, particular care must be paid to the formulation used and the type and degree of mixing if it is desired to produce foams with low moisture permeability. Small cells are the key to low water transmission and the production of small cells depends heavily on the factors above. See *"Designing rigid urethane foams for low moisture permeability,"* by C. M. Barringer, *SPE J. 15,* 961 (Nov. 1959).

Often the development of a new material with unique properties leads to the development of a new fabrication technique. Such is the case with polycarbonate resins. Although the technique is still developmental, polycarbonate resins are reported to be sufficiently ductile to be cold drawn in forming operations similar to the punch forming of sheet metals. Parts must be heat-treated afterwards to avoid stress cracking. Other properties of the cold-formed sheet are also discussed in *"Cold-formed polycarbonate resin—properties and application,"* by G. Gruenwald, *MPI 38,* 137 (Sept. 1960).

Another new fabricating technique is reported in *"Welding with resistance tapes," Plastics* (London) *25,* 159 (April 1960). The paper describes the use of "Thermobande," a special metallic tape of nickel alloy on adhesive paper, in the welding of plastic sheets and films. The tape is placed along the weld line and a low-voltage current is passed through it. This generates enough heat to melt the adjacent plastic and form a weld. Technique was found especially effective for welding high-density polyethylene and polypropylene.

Also of interest to fabricators using heat-sealing methods is *"New data on film heat seals,"* by R. Bosvik, *Modern Pkg. 33,* 123 (Feb. 1960), which presents a detailed study of the heat sealing of PVC films using both the constant heat and impulse sealing methods.

More on the fabricating of sheet, specifically polypropylene sheet, will be found in *"Fabricating and forming Propylex sheeting," Rubber and Plastics Age 41,* 932 (Aug. 1960). The article discusses hot-gas welding, hot-tool welding, vacuum forming, mold design, and adhesives for polypropylene sheet.

In *"Post-molding operations on acetal resin," Plastics Tech. 6,* 29 (June 1960), R. L. Miller tells how to machine, anneal, weld (by four methods), press-fit, screw, nail, and cement Delrin acetal resin. Tables and graphs give machining speeds, expected shrinkages under various use temperatures, joint design details, force developed by interference fits of parts and hole sizes, pullout strengths, and back out torques for self-tapping screws.

The same type of information for high-pressure laminates is presented in *"Do's and don'ts for fabricating laminates,"* by J. E. Martin, *MPI 37,* 116 (April 1960). Specific fabricating operations discussed are punching, sawing, drilling, tapping, turning, milling, as well as shearing.

In the finishing of plastic parts, painting can sometimes be cheaper than molding pre-colored material —particularly where special colors and small production quantities are involved. It can be used to eliminate frequent machine cleanouts and shutdowns, and can minimize inventory requirements. In addition to these advantages, painting can often reduce rejects by hiding minor scratches, dirt, and weld lines in molded parts. For the full discussion see *"Painting vs. molding in color,"* by T. E. Hayden, *SPE J. 16,* 84 (Jan. 1960).

Important to the success of plastic products going into the food industry and the medical field is the ability to sterilize the finished product. *"The sterilization of plastic materials,"* by E. Ferraris, *Materie Plastiche 26,* 259 (Mar. 1960), in Italian, discusses advantages and limitations of both the chemical and physical methods available to accomplish this.

In order to process successfully most of today's plastics materials, good data on the characteristic properties affecting process conditions is always noteworthy.

In one such paper, the degradation curves of both solvent-plasticized and bead-plasticated polymers are reported to be approximately coincident. Molecular weight is found to decrease rapidly and approach a limiting value dependent on the mastication system. For the complete discussion, see *"The mechanico-chemical degradation of plastomers,"* by R. J. Ceresa, *The Plastics Inst. Transactions and Journ.,* Part I, *28,* 178 (Aug. 1960). Parts II and III, *28,* 202 (Oct. 1960).

For detailed analysis of thermal relationships in extrusion and injection molding of polyolefins, it will be helpful to have the heat content-temperature curves contained in *"The specific heat of low-pressure polyethylene,"* by H. Wilski, *Kunststoffe 50,* 335 (June 1960) and *"The specific heat of polypropylene,"* by H. Wilski, *Kunststoffe 50,* 281 (May 1960), both articles in German.

Also, if you are curious about what plastic was used in a particular application and you have a sample part, *"What plastic is it?", MPI 37,* 88 (July 1960), presents a step-by-step outline in chart form for the qualitative analysis of an unknown plastic sample.

Most exciting thing in mold making is the use of the electro-erosion machine for the cutting of cavities. The electrical discharge machine has no problem in cutting even hardened steel of Rockwell hardnesses of about 60 on the C scale. Its chief advantages are fully enjoyed in the construction of complex molds. For a full discussion with several examples of the type of molds which can be produced, see *"Breakthrough in mold-making —electro-erosion,"* by F. Jaques and J. Schmidt, *Modern Plastics 38,* 109 (Dec. 1960).

Another innovation in mold design is described in *"Fabricated (built-up) molds,"* by C. Zehr, *Plastics Tech. 6,* 34 (March 1960). In a built-up mold, the parts are shaped individually with standard machine tools, then assembled by dowelling, bolting, welding, etc. This type of construction is satisfactory for a wide range of molding applications, especially in low-pres-

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sure (< 500 p.s.i.) polyester molding, and offers big savings over traditional monoblock construction. The article discusses situations in which built-up molds are applicable and inapplicable, and shows how several such molds were made.

More on mold design will be found in *"Thermal considerations in mold design,"* by W. J. B. Stokes, *SPE J. 16,* 417 (April 1960), which presents an excellent review of the heat transfer variables involved in mold cooling and heating.

For processors handling plastic webs, an excellent review on winding equipment will be found in *"A guide to winding,"* by S. F. Oakes and A. A. Arterton, *MPI* Part I, *37,* 105 (Aug. 1960), and Part II, *38,* 124 (Sept. 1960). This comprehensive review discusses the types of drives and winding equipment available, and gives tips on how to match the equipment to any problem.

Design and application

Shrinkable polyethylene film with improved strength, clarity, and gloss can be had by combining the processes of biaxial orientation and irradiation. For details see *"Irradiated polyethylene film,"* by R. D. Lowry and W. G. Baird Jr., *Modern Pkg. 33,* 121 (May 1960).

For a roundup of information on all types of oriented plastic film and sheet, see *"Oriented thermoplastic sheet and film,"* by C. P. Fortner, *Mat'ls in Design Eng. 50,* 94 (Dec. 1959). The article tells what materials are usually available in oriented form and discusses the pros and cons of each. Also included is a description of the orientation process, an oriented sheet properties chart, and tips on designing thermoformed products.

If you're a rocket and missile engineer, see the collection of papers under the general title *"Plastics in missiles," Brit. Plastics 33,* 348 (Aug. 1960), which includes *"An introduction to current uses of plastics,"* by D. V. Rosato; *"Thermal and strength requirements for reinforced plastics,"* by A. W. Wilson; *"Insulation and heat-shielding applications,"* by J. Hertz; *"Materials for nozzle insulation,"* by E. M. Gilchrist; *"Filament winding for radomes,"* by W. J. Colson; and *"Controlling materials for missile construction,"* by M. Kushner. Noteworthy about this presentation is the detailed information given in the papers on the performance of various plastics. Another excellent two-part article on missiles, specifically on the process of ablation, is *"Behavior of plastics in re-entry environments,"* by D. L. Schmidt, Part I, *MPI 38,* 131 (Nov. 1960), and Part II, *MPI 38,* 147 (Dec. 1960). A definitive treatment of the subject, the first part deals with the physico-chemical aspects of the process and Part II discusses thermal parameters in detail.

Those missile engineers concerned with the electronic components going into missiles, as well as with embedment and encapsulation of such components, will find an interesting summary of important design parameters, materials selection problems, and processing and application problems in *"Materials and techniques for resin-encapsulated missile circuits," Electrical Mfg. 65,* 70 (May (1960). Included are the test results on two English missiles.

Also on the subject of encapsulation, see *"Heat-resistant encapsulating resins,"* by M. M. Lee and R. D. Hodges, *Plastics Tech. 6,* 43 (April 1960). This meaty article contains a good discussion, from the service standpoint, of the properties required of encapsulating resins and of what an engineer must know about them to use them properly. Numerous tables and graphs show what happens, with many different resins, to such characteristics as deflection temperature, weight loss, and electricals, when the cured resin is held at high temperatures for long times.

Also made available this year was what is claimed to be the "universal" type of embedment compound employing a liquid anhydride curing agent. Results of the development program are presented as well as manufacturing experience with the new system. Nadic methyl anhydride is the recommended curing agent and its use lengthens pot life, gives better finish, results in more latitude in curing speed, and is less toxic to use. Details will be found in *"An improved epoxy resin system for electronic embedments,"* by B. H. Mueller and C. A. Harper, *Elect. Manufacturing 65,* 119 (Feb. 1960).

The importance of plastics as engineering materials in the design and construction of conventional transportation equipment was also evident in the literature. For a discussion of the problems and solutions involved in the use of plastics in the shipbuilding industry, see the series of papers under the general title *"Plastics in shipbuilding," Plastics (London) 25,* 91 (March 1960), which includes: *"New materials for the Canberra,"* by J. West; *"The use of plastics for ships in the U. S. A.,"* by J. B. Alfers; *"The future of plastics in shipping," "Plastics in lighthouse service,"* by R. J. Shergold: *Lifesaving Equipment,"* a staff report; *"Plastics plumbing for ships,"* by F. J. Folkard; *"Nylon for ships' propellers,"* by A. Clark; *"Insulation in ships,"* a staff report; *"Plastics applications in the Canberra,"* by F. R. Hampton; *"Interior applications,"* a staff report; *"Applications overseas,"* a staff report; and *"Miscellaneous applications."* Of interest to builders of small boats made of fibrous glass-reinforced plastics is the article *"Long-term wet strength of polyester resins,"* by C. E. Loetel and H. E. Fordyce, *SPE J. 16,* 1137 (Oct. 1960).

For engineers concerned with the problem of specifying materials for automotive applications, the article *"Automobile bodies in polyester glass," Brit. Plastics 33,* 44 (Feb. 1960), presents an excellent summary and history of the use of plastics in automobiles. The article presents experiences in the construction of several English automobile body types with emphasis on the basic economics of fibrous glass-reinforced plastic construction which typify the most advanced techniques in contact molding. Excellently illustrated. *"1961 autos: proving ground for plastics," MPI 38,* 85 (Nov. 1960), cites many examples of the hundreds of plastics components in use in this year's models, and points out what these automotive applications can signify for end-users of plastics in a range of other industries.

Plastics are also invading the field of railroad rolling stock in a big way. *"Burgeoning bead board*

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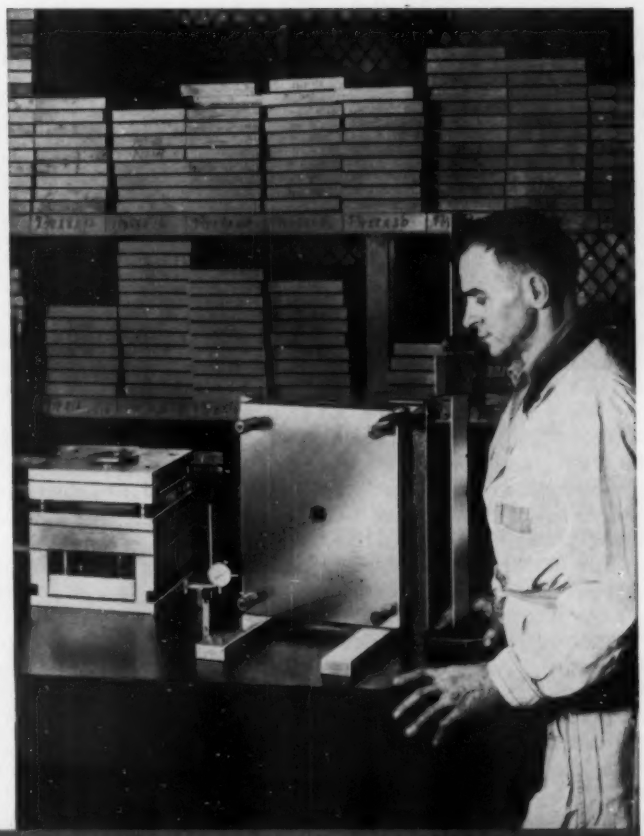

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business," MPI 37, 97 (July 1960), includes a description of the development and manufacture of a polystyrene foam-filled, vacuum-formed, inner door liner of styrene copolymer material for use on Pacific Fruit Express cars. Doors are 9 ft. 3 in. by 8 ft. 6 in. by 8⅝₁₆ in. thick. Construction results in a weight saving of 400 to 500 lb. per door, and provides better thermal insulation even though doors previously used were only 6 ft. wide.

Plastics also go aloft in uniquely designed jetliner seats described in *"RP seats take to the air," MPI 37,* 87 (Feb. 1960). Article describes the development and manufacture of polyurethane foam-filled seats with skins of fibrous glass-reinforced plastic for the Lockheed Jet Star Airliner. These represent a type of plastic product construction that promises to find wide use.

Architects and building construction engineers will find an excellent plastics materials primer in *The building industry issue of the Plastics Institute Trans. and Journal 28,* 2 (Feb. 1960). The entire issue is devoted to the use of plastics in a variety of applications in the building industry.

Another excellent discussion on the same topic will be found in *"Plastics in building," Brit. Plastics 32,* 534, (Dec. 1959), which describes the status and current use of plastics as moisture barriers, in structures (molded beams, adhesives, sandwich panels, foams), in walls, roofs, floors, doors, etc.

Another excellent series on building will be found in *Kunststoffe 50,* 353 (June 1960), and includes the papers, *"An Italian holiday chalet made of plastics,"* by A. Schwabe; *"Large-scale plastic components in housing construction,"* by R. Doernach; *"Plastics in housing construction—a general survey,"* by G. Schulz; *"A plastic house in the bungalow style,"* by R. Frenz; and *"The Styra glass fiber-reinforced polyester window."* All in German.

One of the largest outdoor structures made of reinforced plastics is described in *"Building a giant,"* by G. Fretz, *MPI 37,* 111 (May 1960), which gives the story on how a 140-ft.-diameter radome was designed, adapted for manufacture, and erected. Construction consisted of fitting together 1646 modular panels of fibrous glass-reinforced plastic honeycomb design. Another story on the construction of large plastic structures will be found in *"Reinforced plastic better than steel for storage tanks," Chem. Eng. 67,* 214 (April 18, 1960). Article describes the construction of 12-ft.-diameter chemical storage tanks made by the filament winding process. Tanks are 15 to 24 ft. high. Article illustrates the filament winding machine used to do the job. Also evaluated is the service that can be expected from such tanks in chemical service.

Also being considered for service in chemical plants are plastic-coated valves. *"Fluid bed coat: key to better valves,"* by R. J. Sarraf, *Chem. Eng. 66,* 100 (Dec. 28, 1959), discusses the use of the fluidized bed technique in applying plastic coatings to metal valve bodies. Also mentioned are the service limitations of the coatings and some Do's and Don'ts on design and operation.

Since building design engineers are concerned with the construction of outdoor structures, it will pay them to read *"The weathering of high polymers,"* by H. J. M. Langshaw, *Plastics (London) 25,* 40 (Jan. 1960). This contains an excellent appraisal of the factors involved in weathering processes.

Also important in the applications of plastics in the building field is their fire resistance. An excellent summary of the fire resistance properties of various plastics will be found in *"More progress in self-extinguishing plastics," MPI 37,* 92 (April 1960). This article presents the data in chart form and includes sources of supply. The article is a continuation of the data presented in MODERN PLASTICS in September of 1959. A new approach to increasing the fire resistance of plastic products is the use of *"Flame retardant coatings for plastics,"* by B. J. Tyler, *Mat'ls in Design Eng. 52,* 16 (Nov. 1960). Under the action of heat or flame at 200° F., specially formulated 3-mil coatings puff up into a ½-in.-thick sponge-like insulating mat on the surface of the plastic part. In addition to insulating the part, the coating gives off carbon dioxide which helps smother the flame.

A constantly improving knowledge of plastic properties and the development of new fabricating techniques continues to open up entirely new fields of application for plastic materials. For example, take the field of sporting firearms. The year saw the development of a plastic shotgun barrel. A 20-gage steel tube is filament wound with glass fibers bonded with an epoxy resin. Results: stronger barrel than steel alone, lighter weight, and lower production cost. For details, see *"Now the plastic gun barrel," MPI 37,* 86 (April 1960). Furthermore the gun will probably use shells of the type described in *"Shells and bullets of plastic," MPI 38,* 80 (Dec. 1960). Linear polyethylene replaces the conventional waxed paper tube and provides better dimensional stability and waterproofness in shells; plastic cartridge casings and projectiles also bring added savings and safety to police trainees and hobbyists.

Another novel use for plastic materials is described in *"Damping tapes for vibration control,"* by E. E. Ungar, *Prod. Eng. 31,* 57 (Jan. 25, 1960). Inexpensive, reliable, lightweight plastic tapes are used to dissipate excess vibratory energy to keep resonance stresses in mechanical parts below destructive levels. Tapes of polypropylene, fluorocarbon, and vinyl, as well as other plastics, can be used. This article shows how to select the right material and design the tapes.

More data on design of plastic pipe joints, in this case, for thermoplastic pipe, will be found in an exhaustive, profusely illustrated article reviewing several pipe joining methods: *"Pipe connections for Ziegler polyethylene pipes,"* by K. Richard, E. Gaube, and G. Diedrich, *Kunststoffe 50,* 325 (June 1960). In German.

Two other articles on thermoplastic pipes are worthy of mention; namely, *"Allowable stresses and quality control of rigid PVC pipes,"* by A. A. Van DerWal and S. Heyer, *Rubber and Plastics Age 41,* 169 (Feb. 1960), and *"Strength-testing plastic pipe,"* by F. W. R. Wijbrans, *Plastica 13,* 18 (Jan. 1960). Second article in Dutch. The articles discuss test methods and types of pipe failures. Conclusion is that long-term tests are the only really reliable test methods for evaluating performance.

Regarding molded *(To page 219)*

Unique function of SAIB aids plastics processors

A semi-solid at room temperature, SAIB has a molecular weight of 838. It is exceptionally light in color and unusually stable to ultraviolet light. SAIB exhibits outstanding hydrolysis and thermal stability. (Less than 0.1% is hydrolyzed after refluxing 96 hours with water. Heated to 175°C. for a period of 6 days, its color increases slowly to straw yellow, with no appreciable change occurring until after 24 hours of heat-aging.) SAIB is compatible with a wide variety of polymers, modifiers and plasticizers and is highly soluble in most common solvents. (A 90% solution of SAIB in ethyl alcohol has a viscosity of only 750 centipoises at 30°C.)

When used in conjunction with dimethyl phthalate and other common plasticizers, SAIB offers processors of cellulose acetate plastics the means of achieving

easier dry-blending
faster molding cycles
increased extrusion rates
improved physical properties

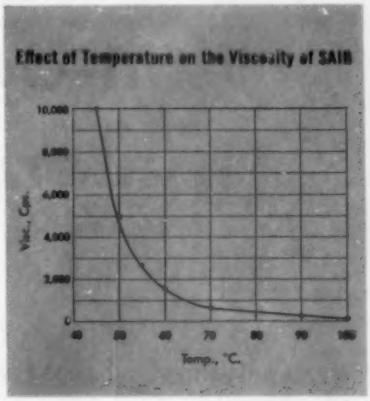
SAIB aids in dry-blending

SAIB deactivates the cold solvency characteristics of dimethyl phthalate and similarly-active plasticizers. By blending SAIB with the plasticizer before compounding, even distribution of the plasticizer throughout the cellulose acetate mix is readily accomplished, eliminating the problem of paste formation.

SAIB increases molding and extruding rates

The presence of SAIB in a plasticized cellulose acetate formulation permits faster, more uniform flow through extrusion and molding cylinders *without decreasing hardness or flexibility*.

As illustrated in the graph, SAIB has an extremely high temperature-viscosity index. Note that at 70°C., its viscosity is less than 1,000 centipoises. Below this temperature, however, a sudden increase occurs. At 50°C., its viscosity is approximately 4,500 centipoises. At room temperature, it becomes a semi-solid.



At molding or extrusion temperatures, SAIB aids in plasticization, while at room temperature it has the opposite effect, stiffening the plastic and increasing its surface hardness. This unique behavior of SAIB permits molding and extrusion conditions applicable to a material one or two flows softer than its hardness and rigidity at room temperature would indicate.

Similarly, in vacuum-forming, cellulose acetate sheeting formulated with a dimethyl phthalate-SAIB blend submits to deeper drawing before blushing occurs, again because of this unusual temperature-viscosity relationship.

SAIB improves physical properties

Modification of cellulose acetate formulations with SAIB increases hardness, rigidity and tensile strength, and decreases weight loss on accelerated aging.

Note that this improvement in physical properties achieved at practical flow temperatures is due to the behavior of SAIB and not to a decrease in plasticizer content. Dimethyl phthalate-SAIB formulations exhibiting physical characteristics in the range of H 5 or H 6 have been extruded without difficulty.

Hot melts, peelable coatings

With its excellent permanence, compatibility and stability characteristics, SAIB can be used to advantage in hot melt and peelable plastic formulations.

Tough, flexible melt coatings can be made containing up to 70% SAIB. One of their outstanding features is a complete absence of fuming at melt temperatures. Operating temperatures are lower, too. The usual application temperature for conventional butyrate hot melts is 350°F. With high SAIB modification, optimum operating temperature is only 275°F.

In ethyl cellulose compositions, SAIB acts as a solubilizer for mineral oil, reducing exudation of the oil from the film and enabling the formulator to use increased amounts of oil.

In peelable coatings, SAIB improves resistance to exudation, thus maintaining flexibility.

SAIB is so unusual—acting as a plasticizer under certain conditions, and as resin extender under others—you will want to try it in your own formulations, under your own processing conditions. You can get a sample of SAIB, as well as a technical report on its physical properties and performance, by writing to your nearest Eastman sales office or to EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENN.

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The year 1960 in review

The '60s have brought to the plastics industry new challenges to provide the lightweight materials needed to construct the vehicles of the Space Age. Already promising progress in this direction is evident in the reports from the Army Ballistic Missile Agency (1) and the Wright-Patterson Air Force Base (2), describing the successful development of reinforced-plastic nose cones resistant to the hyperthermal environment encountered in the flight of missiles and re-entry satellites. Extreme temperatures and aerodynamic heating associated with these vehicles are accommodated with ease by a phenomenal heat and mass transfer process known as ablation. Since the efficiency of reinforced plastic ablation systems has been found to increase with increasing heating rate, there appears to be no practical upper limit to the thermal environment for which these plastics may be applicable.

But resistance to radiation and to the essentially complete vacuum of near and outer space are also required in these vehicles of the future. Methods must be developed to measure these effects accurately and quickly. The use of plasticizers and stabilizers that have significant vapor pressures at high vacuum is precluded in such applications (3). The characteristics of plastics in moisture-free environments with respect to strength, abrasion resistance, coefficient of friction, and other important properties must be taken into account. The Echo I balloon has demonstrated that polyethylene terephthalate film is especially suitable for at least one type of satellite (4).

A report of the Department of Defense emphasizes areas of research that need to be given strong support to provide the basis for the improved plastics needed in these space programs (5). Specifically, knowledge is needed on 1) the thermodynamics of macromolecules, 2) the relationships between polymer structure and performance dependent upon stress, time, temperature, and environmental factors, 3) adhesion between polymers and fillers, particularly the effects of surface treatments of glass fibers on this parameter, and 4) orientation effects for high modulus and strength in fiber reinforcements.

Another area reported to be little understood and not systematically explored is that of composite materials made up of metals, glass, plastics, and adhesives; it is anticipated that such composite structures will be required not only for combatting the thermal environment, but also to meet the needs of radiation shielding, sonic fatigue resistance, and the problem of collisions with particulate matter in space.

The use of plastics in advanced aerospace vehicles is expected to become more general. In fact, some researchers predict that some large future satellites will be made almost completely from nonmetallic materials (6).

A comprehensive handbook on basic mechanical properties, strength and elastic relations, and environmental factors affecting properties of reinforced plastics for flight vehicles has recently been published (7). Many other reports of investigations bearing on this subject and of technological developments in the application of plastics in the exploration of space will be found in this review.

Radiation and grafting

Investigations of radiation effects in polymerization reactions and on the properties of polymers were reported from many sources (8-10). The specific materials worked with included polyvinyl chloride (11, 12), polyethylene (13-15), fluorocarbons (16, 17), acrylonitrile (18), polysiloxanes (19, 20), polystyrene (21), and poly-α-methylstyrene (22). The preparation of graft (23) and block (24) copolymers was studied, with particular

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* Reg. U. S. Pat. Off.

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attention to ethylene and styrene (25), ethylene oxide and styrene (26), as well as cellulose derivatives (27, 28).

Plastics are finding important uses in high-energy nuclear accelerators (29, 30) and in atomic reactors (31, 32). Polyethylene provides a lightweight and space-saving radiation shield, particularly advantageous in aircraft and marine installations (33).

Acrylics

Developments in the preparation (34, 35) and processing (36, 37) of acrylic plastics were reported, especially for copolymers of methyl methacrylate with styrene (38, 39) and methylstyrene (40), and acrylonitrile with styrene (41). Physical properties (42, 43) and thermal stability (44, 45) of acrylic polymers were investigated. Procedures were described in the various articles for the analysis of acrylic materials employing chromatography (46-48), spectrophotometry (49, 50), as well as color reactions (51).

Epoxies

Many new developments in formulation of epoxy resins were reported during the year (52-56). Epoxidized olefins and terpenes impart: 1) low order of toxicity, 2) reduction of viscosity, 3) increased pot life, 4) lower exotherm, and 5) increased flexural strength to casting resins (57). Four new cycloaliphatic diepoxides yield resins that have improved light stability, lower viscosity, higher heat resistance, and greater chemical reactivity with readily available, low-cost, acid anhydride hardeners (58). Various methods were described for determining the reaction mechanisms (59) and curing rates (60-63) of epoxide materials. A noteworthy contribution was made to our understanding of factors involved in the stability of epoxy plasticizers, leading to better performance in vinyl compounds (64).

A series of articles on markets for epoxy resins concluded with a prediction that the 100-million-lb. consumption figure will be reached in 1963, with one-half of this output going into protective coatings (65). Other products or applications in which epoxies are used include tooling (66), potting and encapsulation (67-72), laminating (73, 74), adhesives (75), automobile body solder (76), flooring (77), road surfacing (78, 79), boat building (80), piping, process equipment (81), television tubes, optics, safety glass, and construction materials (82, 83). Production volume of epoxies reached approximately 56 million lb. in 1959.

Relationships between molecular structure and physical properties of epoxy compounds were explored by various investigators (84-88). Commercial production methods and equipment for mixing, metering, dispensing, and molding epoxy resins were described (89).

Fluorocarbons

The search for polymers of greater chemical and heat resistance was highlighted with reports on polyvinyl fluoride (90, 91), polyvinylidene fluoride (92), fluorinated polyamides (93), perfluoro-

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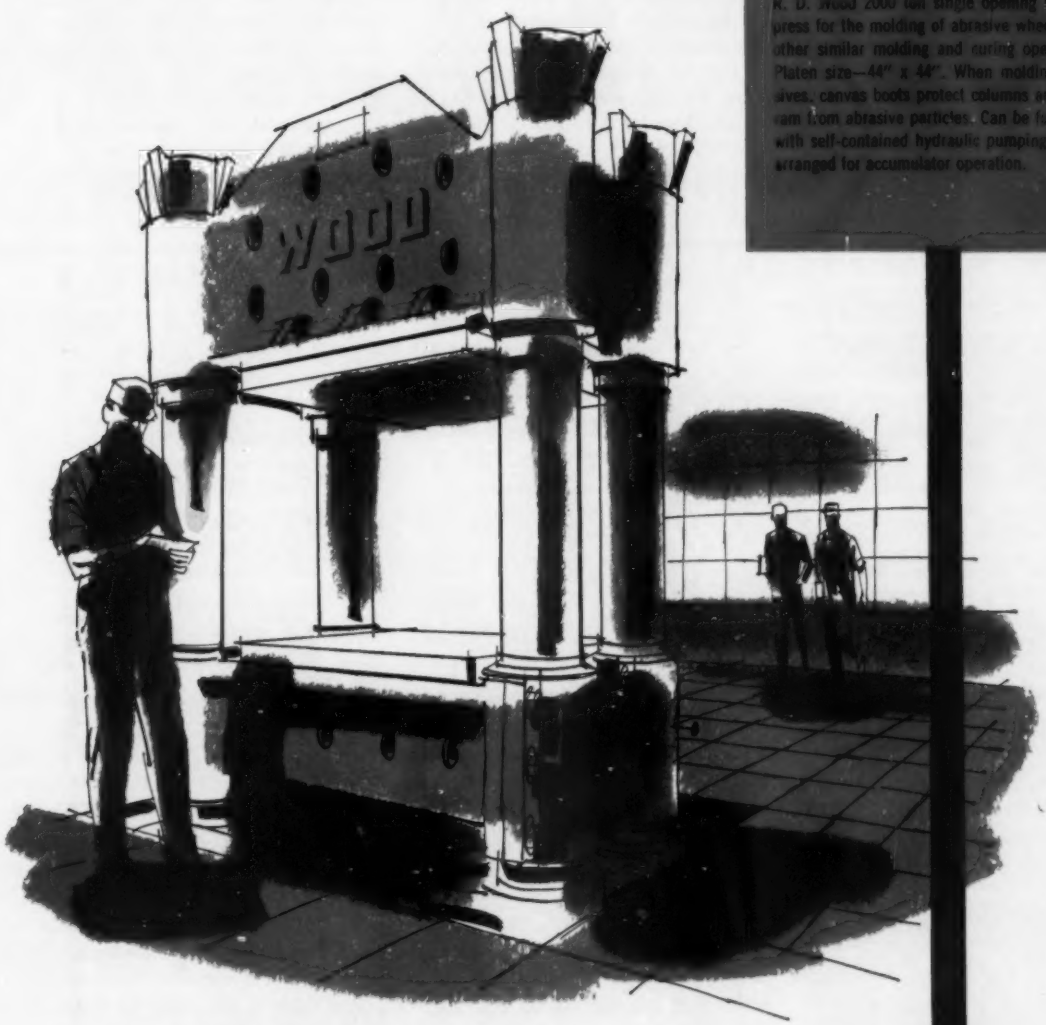

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alkyldiamidines (94), and copolymers of vinylidene fluoride with hexafluoropropylene (95, 96) and of tetrafluoroethylene with trifluoronitrosomethane (97) and hexafluoroethylene (98). Improved techniques for extrusion of fluorocarbon resins (99, 100) and for their application as coatings (101) were described. New data were published concerning their permeability (102), phase transitions (103), wettability (98, 104), and torsion modulus (105). Steel pipe lined with TFE-resin is competing favorably with glass-lined steel and Monel pipe (106). Polychlorotrifluoroethylene was reported to be the only plastic that will transmit in the infra-red when properly formed and heat treated (107).

Olefins

The polyolefins now account for more than 20% of all plastics production, and their impact is also evident in the voluminous literature that is currently appearing regarding their preparation, processing, properties, and applications (108, 109). Polypropylene, the new member of this family, is now being produced at an estimated annual rate of 50 million lb. and is expected to expand this rate tenfold by 1964. The major markets are expected to be in film, filaments, and injection molded products (110-115).

Giant thermoformed parts up to 12 ft. long and 4 ft. wide are opening up new markets for high-density polyethylene in small boats, construction equipment (mixing pans, chutes, and the like), and missile, aircraft, and automotive applications (116). Significant developments were reported in compounding crosslinked polyethylene (117, 118), coloring (119), welding (120), coating paper (121, 122), blowing film (123), thermoforming (124), injection molding (125-130), and extrusion (131-136) of polyethylene. Test methods and data were presented concerning creep characteristics (137), flow properties (138, 139), film bursting strength (140), brittleness temperature (141), internal stresses (142), phase changes (143-146), corona resistance (147, 148), wettability (149), diffusivities of various gases (150-155), thermal stability (156), effects of thermal history on mechanical properties of polyethylene specimens (157, 158), oxidation mechanisms (159-161), and characterization by differential thermal analysis (162). Stabilization of polyethylene against oxidation (163, 164) and ultraviolet light (165) was investigated.

Copolymers of ethylene with propylene, butene-1, and acrylic esters are becoming commercially important because they offer ready solutions to such major problems as environmental and thermal stress cracking, and low-temperature brittleness, as well as processing diffi-

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Water (Wt. Per Cent)	max. 0.10
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culties, without any significant increase in cost over polyethylene (166-170).

Polyamides

The relatively costly nylon plastics are competing to the extent of about 40 million lb. per year because of their toughness, dimensional stability, abrasion resistance, and low coefficient of friction. Molybdenum disulfide in nylon-6/6 imparts lubricating qualities and promotes greater and more uniform crystallinity in injection molded parts, resulting in improved performance and economies in production of wear parts, such as gears, cams, bearings, washers, and switch components (171). Polyamides made from a variety of acids and amines were investigated (172-175). Problems in injection molding (176, 177), extrusion (178), and machining (179) of nylons were discussed. New data were reported on dynamic mechanical properties (180, 181), viscoelastic behavior (182), dielectric properties (183), crystalline structure (184), water sorption (185, 186), and thermal stability (187) of polyamides. The impact resistance, impermeability to oils and solvents, and heat-sealability of nylon film are advantageous properties for packaging (188).

Polyesters

This group of resins is growing rapidly in commercial importance, expanding more than 50% in 1959; approximately 70% of the 180 million lb. produced went into reinforced plastics (189). Reports appeared on the use of tung oil and its derivatives (190) and isophthalic anhydride (191) in polyester synthesis, on curing agents for polyester resins (192, 193), and on the analysis of polyesters (194-196). Properties related to uses of polyesters in corrosion-resistant equipment (197), encapsulated electronic units (198, 199), and packaging film (200-202) were discussed. Development of a process for bonding decorative polyester film 0.3 mil thick to continuous coils of strip metal makes available a plastic-metal laminate that is expected to find major outlets in television cabinets, home appliances, furniture, and automotive trim (203). High point of the year for PE terephthalate was the launching of 150 lb. of it into orbit in the Echo I balloon (4).

Styrene polymers and copolymers

Close to 1 billion lb. was produced in 1960. Approximately two-thirds of this production is polystyrene and one-third comprises its copolymers. Foam is the most rapidly growing field for polystyrene, with 100 custom molders entering the business in the past five years to produce end products for packaging, displays, flotation, appliances, insulation, toys, building construction, and furniture (204-206). New techniques for manufacturing foamed polystyrene products have been developed (207-210). Reports were published on a new plant process for production of styrene and PS (211), glass-filled polystyrene molding compound (212), forming boxes from biaxially stretched film and sheet (213, 214), ultrasonic degradation of PS (215), and its photoelastic (216), rheological (217), and physical (218) properties.

An all-hydrocarbon thermosetting resin comprising a copolymer of butadiene and styrene with vinyl groups attached to the main chain is in semi-commercial production; it is expected to be particularly suited for electrical applications because of its very low water absorption and the stability of its excellent electrical characteristics over a wide range of temperature and current frequency (219). Developments were also reported in copolymers of styrene with divinylbenzene (220), acrylonitrile (41), and methyl methacrylate (38, 39),

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acrylonitrile-butadiene-styrene plastics (221, 222), and rubber-modified polystyrene (223).

Urethanes

Production figures, released for the first time by the Tariff Commission for this group of plastics, revealed that approximately 5 million lb. of isocyanate resins and 2 million lb. of polyurethane elastomers were made in 1959. Developments in rigid and flexible urethane foams were the focal point of major attention (224-231), but advances were also reported in elastomeric compounds (232-238), coatings (239), laminates (240), fibers (241), propellant binders (242), and heels and finishes for shoes (243). Formulation variables and composition-property relationships were explored (244-247).

Vinyl polymers, copolymers

This branch of the industry is looking to the construction field for markets to reach its next goal—2 billion lb. annual consumption. Applications now in existence or under development include window sash, slide, and frames; pipe and conduit; stair railing caps; baseboards; weather-stripping; waterstops; moisture vapor barriers; shutters; and vinyl-metal laminated or coated construction parts (248).

The Ford Motor Co. plant, which produces more than 6 million linear yards of PVC-coated upholstery fabric annually, has modern equipment for bulk handling of resins and plasticizers, compounding, calendering the paste into film, laminating with fabric, printing, and embossing, including electronic and Beta-ray equipment for accurate control of the critical calendering operation (249).

Many new techniques for processing PVC resins into finished products were described, including extrusion of film, sheeting, and shapes (250-252), slush molding of plastisols (253), extrusion coating and calendering of plastisols on various substrates (254-257), fluidized bed coating of metals (258), spray finishing (259), and lamination to metals (260) and fabrics (261). New data and test methods were reported concerning the thermal and light stability of PVC compounds (262-269) and the properties of vinyl-coated fabrics (270).

Polyvinyl acetate (271) accounts for 140 million of the 260 million lb. of vinyl resin production exclusive of the vinyl chloride group. Major quantities of these other vinyl resins go into adhesives (60,000,000 lb.), protective coatings (25,000,000 lb.), interlayer for safety glass, thickeners for various processing and coating operations, and specialty packaging films. Specific reports dealt with polyvinyl alcohol (272, 273), formal (274), alkyl ether (275), as well as carbazole (276).

Other polymers

The successful application of rapid cold-forming techniques, such as are used in shaping metals, to the production of polycarbonate parts of complex designs opens up a wholly new technology for the processing of plastics (277). This new resin has already found uses in electrical equipment, machine housings, cameras, household appliances, and automotive parts (278-280).

Photosensitive polymer compositions that respond to both ultraviolet and visible wave lengths of light are in an early but promising stage of development (281, 282). Another area of pioneering research is that of organic semiconductors; the possibility exists that some polymers may find specialty applications in electronic equipment because of their ability to conduct small electrical currents rather than functioning in the usual capacity of polymers as insulators (283).

Coordination polymers, some-

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times referred to as chelates, are of interest because they may lead to polymers of high thermal stability and mechanical strength; metal ions are linked by organic compounds to form polymer chains (284). Developments in inorganic plastics were reviewed (285, 286) with particular reference to phosphonitrilic chloride polymers (287). New routes to flame-resistant polymers were foreseen in trichloropropene (288) and polyphosphates, phosphonates, and phosphonamides (289). Advances were reported in the technology of polyformaldehyde (290-292), chlorinated pentaerythritol (293), phenolic resins (294-296), urea and melamine resins (297-300), chlorosulfonated polyethylene (301, 302), silicones (19, 20, 303-307), rubber-resin compositions (308-310), ion exchange resins (311), and cellulosics (27, 28, 312-315). Other polymers dealt with in the literature include butadiene polymers and copolymers (316, 317), chlorobutyl (318) and carboxylated elastomers (319), furfuryl alcohol impregnants (320), rosin esters (321, 322), phenylene sulfides (323), thioglycols (324), vinylcycloalkanes (325), polyspiroacetals (326), and polyoxetanes (326). Polymerization techniques were reviewed (327, 328).

Reinforced plastics

Consumption of reinforced plastics by 1965 is predicted to be 525 million lb., approximately double the 1959 figure (329). Noteworthy applications described in the 1960 literature include a 140-ft.-diameter radome (330), shelters fabricated on-site for housing personnel and electronic equipment (331), a filament-wound gun barrel having a steel liner 20 mil thick (332), a brine tank for water-softening systems costing 25% less than its steel counterpart (333), continuous reinforced pipe made by a novel system of collapsing mandrels (334), flat springs (335), missile nose cones (1, 2), rocket motor parts (336-338), porous laminates for prosthetic devices (339), and sandwich structures fabricated by novel techniques (340-342).

State-of-the-art reports reviewed developments in reinforced plastics molding involving filament winding (343), contour weaving (344), pre-impregnating fibrous or porous webs (345), premixes (346, 347), wet slurry preforming (348), and reduction in die costs by use of reinforced plastics molds (349). Effects of resins (350-353), reinforcements (354, 355), glass fiber treatments (356, 357), and molding variables (358) on strength and performance of the finished product were explored. Various techniques for fabricating (359-361) and postforming (362) laminates were described. Reports on properties of reinforced plastics (7) dealt in particular with heat resistance (363), electrical characteristics (364), long-term stress resistance (365, 366), tensile-impact

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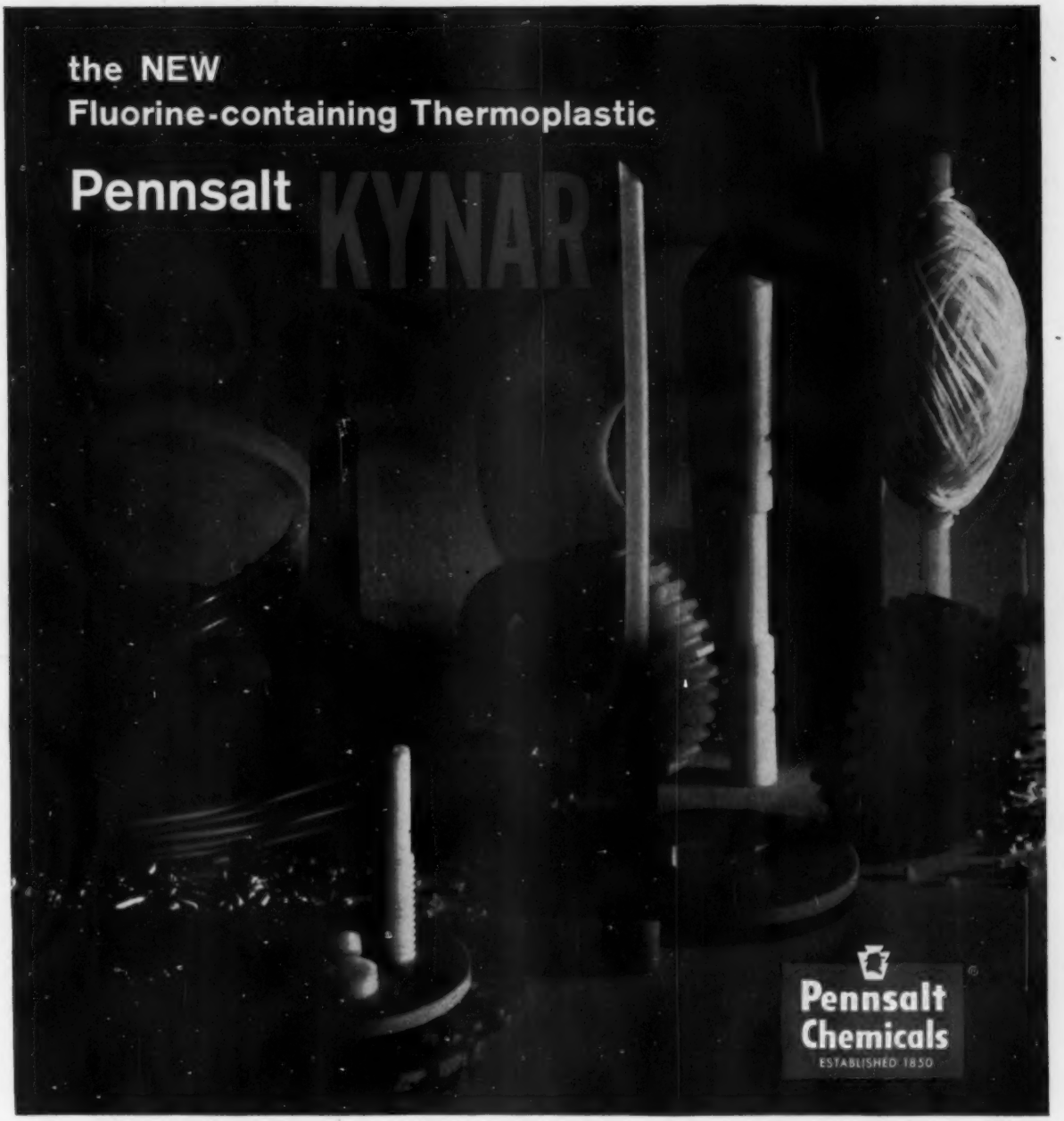

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strength (367), and nondestructive methods for detecting various kinds of flaws (368, 369).

Foamed plastics

Styrene (204-210) and urethane (224-231) cellular plastics received major attention in this rapidly growing sector of the plastics industry (370, 371). Polystyrene foam slab stock for thermal insulation of refrigerating equipment, pipe lines and ducts, and housing units is currently being made at an annual rate of 250 million board feet, requiring about 18 million lb. of resin, but there is still greater potential growth ahead (204, 205). Packaging (372, 373) and encapsulation of electronic equipment for missiles (374, 375) represent other important markets for low-density plastics. Studies were made of moisture permeability (376), tear strength of elastic foams (377), and quantitative determination of open cell and average cell volume of foamed products (378).

Plasticizers, colorants, stabilizers, fillers

Plasticizer production in 1960 expanded 25% to reach approximately 525 million lb., of which about 300 million lb. were phthalate esters (379). New plasticizers described included fire-retardant trichlorobutylphosphate (380) and derivatives of tetrahydrofurfuryl alcohol (381). Specific effects of various plasticizers on properties of vinyl resin compositions (64, 382) and of sucrose acetate isobutyrate on cellulose plastics (312) were described. Procedures for analysis of plasticizers (383, 384) were reported. The amendment to the Federal Food, Drug, and Cosmetic Act, effective March 6, 1960, had a major impact on selection of plasticizers (385) and colorants (386, 387, 119) to comply with the criteria for nontoxic ingredients for plastics to be used in various applications within the purview of that law.

Many significant findings were published on stabilizers (3, 388) and specifically on the stabilization of vinyl (262-266, 389, 390), polyamide (172), polyethylene (163-165), and hydrocarbon (391) systems. The effects of fillers on the properties of adhesives (392), foams (370), epoxy casting compounds (73), and crosslinked polyethylenes (118) were investigated.

Processing

Basic problems in the selection of materials and fabricating processes for specific plastics products were covered by various authors (393-398). The application of metal-working techniques to the cold forming of plastics came closer to realization with the announcement that polycarbonate resin sheet stock has been successfully drawn, shaped, punched, and embossed using mill rolls, presses, dies, and jigs regularly employed in shaping metal stock (277). Fluidized bed coating techniques for applying finely divided plastic powders to preheated, electrostaticized, or adhesive-coated parts received major attention (399-401); application of the process to cellulosic (399), polyvinyl chloride (258), epoxy (399), fluorocarbon (101), nylon (399), polyethylene (399), and chlorinated polyether coatings (399) was described. The Engel process for molding large objects by fusion of the plastic powder to relatively inexpensive molds fabricated from light-gage sheet steel is currently used for polyethylene, but it is expected to be applicable also to production of parts from polypropylene, nylon, and cellulose acetate butyrate (402). Materials, molds, and procedures for casting, potting, and encapsulating objects were also featured (66-68, 306, 403-406).

Electronic computers were applied for the rapid calculation of the gross flow process of a molten polymer in a cold mold cavity from known rheological and thermal properties of the polymer (407). Machine and processing variables that affect the properties of formed plastics parts were dealt with in papers specifically pertaining to compression and transfer molding (408-412), injection molding (413-418), extrusion (419-

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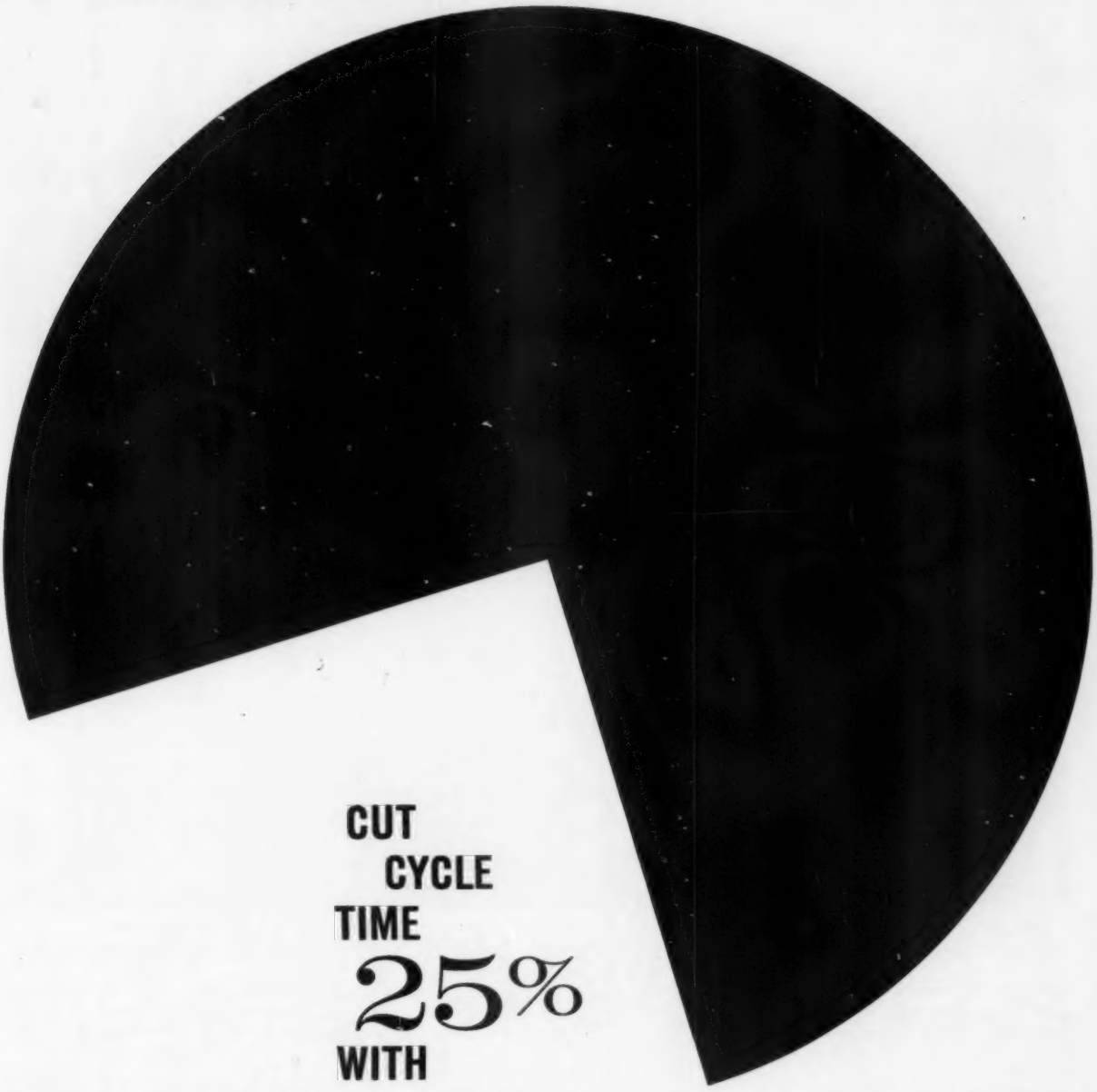

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422), blow molding (423-425), thermoforming (116, 124, 426), pressure forming (427), free blowing of acrylic spheres (36), orientation of thermoplastics by uniaxial or biaxial stretching (131, 213, 214, 428), and molding reinforced plastics (429-431). Fabricating and finishing problems were covered in articles on tumbling thermoplastics (432), optical gaging of dimensions of molded parts (433), measurement and control of static charges (434), polyethylene printability (435), heat sealing (436), film winding (437), fastening devices (438), and machining glass-reinforced laminates (359-362, 439). A breakthrough in mold making is seen in the use of electrical discharge machines to cut precision cavities in steel (440).

Applications

The Space Age has brought new challenges to the plastics industry for the development of materials suitable for missile nose cones (1, 2, 441), rocket motor nozzles and insulators (336-338) and binders for solid propellants (242, 442-444). Plastics films can also play an important role in the space program (445). The Echo I satellite, 100 ft. in diameter and approximately 200 lb. in weight, including 30 lb. of benzoic acid and anthraquinone to supply gas for expansion, is made of aluminum-coated polyethylene terephthalate film 0.5 mil thick (4).

The aircraft industry utilized various resinous materials for sealants (446), propeller liners (447), air-conditioning systems (448), and radomes (341). The automotive industry is a big consumer of plastics for upholstery (249), and interior accessories and trim (449), and is exploring new uses in truck bodies (450), fairing compounds (76), glazing (451), and other applications (452, 453). In 1960 approximately 40% of the 329,000 outboard pleasure boats sold were made of reinforced plastics and this percentage is expected to continue to increase. Moreover, 40-ft motor yachts are now being made of RP on a production-line basis and the U. S. Navy is using this construction material for boats up to 50 ft. in length (329, 454, 455).

Symposia in this country and abroad served to focus attention on the growing applications of plastics in the building industry (456, 457). Developments in reinforced plastics (330, 331), sandwich structures (340), vinyl plastics (248), epoxy compositions (82, 83), and sealants (458) for this market were described. The chemical industry is using resinous corrosion-resistant coatings (81, 459, 460), plastic piping (106, 131, 334, 461-463), and glass-filament-wound epoxy-bonded storage tanks up to 20,000-gal. capacity (333, 464, 465). The equivalent of 365,000 tons/year of packaging, building, and insulating papers have been replaced with plastics (466, 467), and this trend seems likely to continue because of cost competition and diversity of properties available through film laminations (468). Other advances have led to greater use of plastics in packaging (469-472).

Microporous plastics are expected to yield water-repellent clothing with the breathability of ordinary fabrics (473). Significant developments were reported in the use of plastics in the shoe (243, 474) and textile (241, 475) industries. Greater military use of plastics is foreseen in ABS training shells (222), polyethylene-steel shotgun shells (476), revolver training cartridges molded of polyethylene and nylon (476), plastic rifle barrels (332), polyethylene canteens (477), and polyethylene bags for decontamination of clothing with ethylene oxide (150). Noteworthy applications of plastics were made in the medical field (478-483), post office equipment (484), agriculture (485), plumbing fixtures (430), phonograph records (412), molded polypropylene luggage (113), lighting (486), bearings (487), road surfacing

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(78, 79, 488), flooring (77), and synthetic fiber screens on paper mills (489).

Developments in fluidized bed coating (101, 258, 399-401), epoxy (64), vinyl (259), and polyurethane (239) finishes, and novel test methods (401, 490-492) highlighted advances in the protective coatings industry which consumed over 1 billion lb. of synthetic resins in 1959 (493, 494). Improvements in epoxy (75), vinyl (271, 275), phenolic (495), and hot-melt (496) adhesives and techniques for bonding silicone rubber (304), fluorocarbons (16), sandwich constructions (341), and vinyl to metal (260, 497) were indicative of progress in the adhesives field, which consumed over 500 million lb. of synthetic resins in 1959 (498-500). New data on strength properties (392, 501, 502) and improved test methods for a number of adhesives (503, 504) were reported.

Properties

Many notable contributions were made to a better understanding of the physical properties of plastics, including creep (137, 462, 505-508), stress relaxation (509, 510), dynamic mechanical response (13, 511-513), viscoelastic behavior (138, 139, 257, 514-518), flexural strength (42, 519), impact resistance (294, 520, 521), hardness (522, 523), abrasion resistance (524, 525), environmental stress cracking (526), elastic moduli (527), heat distortion (528), necking and cold drawing (529), and the measurement of internal stresses (142, 530, 531) and tensile properties (532, 533). The test methods and results obtained in evaluating the flammability of plastics and progress achieved in the development of self-extinguishing compounds were reviewed (534). New data were presented on the thermal (535-537) and weathering (342, 538-540) stability of polymers, degradation by mechanical working (541, 542), as well as on the electrical properties (543, 544).

Techniques utilized for exploring the structure and behavior of polymeric materials included differential thermal analysis (162, 545, 546), nuclear magnetic resonance (547), ultrasonics (215, 368, 548, 549), electric polarization (550), adsorption (551, 552), fractionation by gradient elution (553), dynamic mechanical determination of molecular weight (554) and crystallinity (555, 556), and measurement of density by means of gradient columns (557). The importance of diffusion of gases and vapors through polymeric materials as related to their physical behavior in different environments and their suitability for various packaging and engineering applications was emphasized by the numerous permeability studies reported (150, 376, 558-570), *(To page 220)*

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4th TOKYO INTERNATIONAL TRADE FAIR

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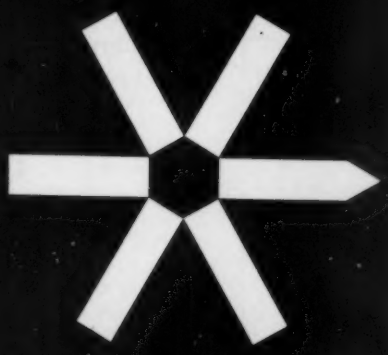

1961 PLASTICS-HALL

Under the auspices of The Japan Society of Plastics Technology (Nippon Gosei Jushi Gijutsu Kyokai) a panorama of the plastics industry and its products will again be displayed at the coming Tokyo International Trade Fair — April 17-May 7, 1961. Every effort has been made by the sponsors to make the huge display more interesting, more comprehensive and more rewarding than ever before.

This is the one occasion during the year when foreign visitors have the opportunity and convenience of seeing Japan's top-ranking plastics makers exhibiting their products side by side. As still another feature, various overseas exhibits will also be shown, providing visitors with handy and attractive points of reference.

Approximately 15,000 items will be exhibited by 106 companies, occupying a total of 350 display booths. The actual floor space of the Plastics Hall will be 5,030 sq. m.

Leaflets and visitors cards are available on request.

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Various plastic materials — phenolic resin, urea resin, melamine resin, polyester resin, silicon resin, polyethylene, polyvinyl chloride, vinyl acetate resin, cellulose acetate, fluorine resin, polyamide resin, synthetic rubber, polypropylene, glass fiber, paper and cloth processing resin, coloring agents, solvents, paints, adhesives, etc.

Machinery (all with demonstration) — injection molding machine, compression molding machine, vacuum forming machine, pulverizing machine, high frequency welding machine, calender, molds, etc.

Products — plastics construction materials (tiles, blinds, lighting fixtures, furniture, accessories, decorative sheets), autos and accessories, auto parts, boats, ships, crash helmets, general sundries, various utensils, toys, vinyl chloride products (bag, shoes, tile, leather, pipe, tube, hose, pipe, etc.), laminated products, ringlon film, polyethylene film, handles, cabinets for artificial flowers, phenolic bowls, bars and tubes, plastic wiring, plumbing equipment, carpets, synthetic fibers, cellulosic materials, acrylic foam, various parts for electrical, chemical, textile industries, etc.

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Door shipped in PE bag

More and more industries are discovering the money-saving protection polyethylene bags can offer to their products on the way from the factory to the customer.

Latest confirmation of this trend comes from Midwest Forest Products Inc., St. Louis, Mo. The company is now packaging its pre-finished doors in polyethylene bags supplied by Bemis Bros. Bag Co., St. Louis, Mo.

The bags, perforated at standard door length intervals (82½ in., which includes ½ in. for closing) and made in varying widths, are put up in rolls. The rolls are hung on overhead racks on one side of the finishing room (see photo). To package the door, a bag is slipped over each unit immediately after finishing and separated from the roll at the perforation. The bag is then closed with staples driven through the folded end into the door bottom. Hinges are installed over the bags prior to shipment.

After receipt by the builder, the door remains encased in the bag through final installation and painting of the surrounding walls—and often until the home owner has moved in.

As to the cost, a Midwest Forest spokesman states that "if we prevent the damaging of one door out of 100, we've saved money." During the initial test, over 1000 doors were shipped in such bags, without damage.

The success of this application will undoubtedly lead to a further growth of industrial packaging uses of PE film. It is becoming increasingly clear that, for finish protection, the polyethylene bag is going to be a hard contender to beat.

Movable letters

Molded butyrate letters, designed to swap-fit onto patterned panels, make possible indoor and outdoor sales and merchandising messages that can easily be changed when necessary.

Both panels and letters are made in a variety of sizes. The panels can be cut with scissors or overlapped and joined to produce almost any desired size.

The letters are injection molded in red and black in 2-, 4-, and 6-in. size; list price for a full font (165 characters) is $80.22, $95.05, and $110.15, respectively. Short fonts (99 characters) list for $48.25, $56.95, and $66.05, respectively. Tapered projections molded into the underside of each letter provide the anchor by which the letters are held in the board.

Panels are vacuum formed in a waffle pattern of 0.050-in. polystyrene sheet for indoor use, and 0.060-in. butyrate sheet for outdoor applications, in either yellow or white. After forming, the panels are punched to provide the holes into which the letters fit. Cost of a panel 26 by 120 in. is $59.95. Other sizes are 26 by 60 in., and 26 by 30 inches.

Both letters and panels are produced by The Adaptaplex Co., Portland, Oregon.

Anti-corrosion coating

A spray coating said to impart a corrosion-resistant surface to metals, wood, and concrete has been developed by Owens-Corning Fiberglas Corp., New York, N. Y. The coating consists of a homogeneous mixture of Fiberglas Flake (resembling fish scale but less than ½-mm. thick and of pin-head diameter), polyester resin, fillers, accelerator, and pigment (if desired). A 20-mm. coating has 50 layers of Fiberglas Flake, roughly the equivalent of getting 50 coats of paint in one application.

A spray gun unit especially designed for applying the product has been developed by DeVilbiss Co., Toledo, Ohio. The basic equipment consists of a pump, spray gun, air compressor, 5-gal. pressure tank, air regulator, flow meter, and air and fluid hoses.

According to Owens-Corning, accelerated weathering tests have shown virtually no deterioration of the coating; other tests reported by O-C indicate a vapor transmission that is essentially zero, shear strength of 800 p.s.i., and dielectric strength of 500 v./mm. The company claims that the problem of pinholes found with some types of protective spray coatings is eliminated by the isolation of air bubbles with many layers of flake. Sagging on vertical surfaces is eliminated by the shear force between the flakes. Surface haze is no problem because the flake forms an air barrier without the addition of haze forming waxes. The flake reduces cure shrinkage, resulting in better adhesion.

One of the first major applications involves the deteriorating iron hull of the 88-year-old *Joseph Conrad*, famous full-rigged ship. The coating area involved is 4600 sq. feet. Glass Plastics Corp., Linden, N. J. is applying the coating at the Thames Shipbuilding Yard, New London, Conn. The iron plates of the ship were badly corroded and pitted, particularly under the water line. In some places, the plates were beyond the point where the welding of patch plates would be practical, since the cost of each new plate plus installation would exceed $1000. The new coating now encases the entire hull, reducing maintenance.

(More on page 162)

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❸ Excellent dimensional stability
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EGAN PRESENTS A COMPLETELY NEW LINE OF EXTRUDERS *with the improved Willert temperature control system!*

Now better than ever . . . Egan's famous "Willert Temperature Control System," which gained world-wide acceptance in the thermoplastics extrusion field for its uniform thermal regulation, regardless of viscosities or melt temperatures!

The heart of the new Willert System is its AIR COOLED CONDENSERS, which are constructed of high pressure finned tubing and are mounted within the cylinder covers of the extruder. Automatically controlled blowers are mounted in the base (see photo at lower right).

Egan Extruders equipped with the improved patented Willert Temperature Control System automatically dissipate excessive frictional heat. The result is closer tolerance extrusions at greatly increased outputs.

Egan Extruders with the new Air Cooled Willert System are available in sizes from 2" through 12", with L/D ratios of 20:1, 24:1, 32:1.

DESIGN AND GENERAL CONSTRUCTION

With this system, each individual zone along the cylinder is jacketed. The jacket is formed by a series of circumferential grooves, connected by channels on the top and bottom, with steel sleeves welded on the outside. An air cooled reflux condenser assembly is connected to the top of each jacket and a condensate return line connects the vapor pressure chamber and the bottom of cylinder. All joints, with the exception of the vent valve and filler plug, are welded to eliminate the possibility of leaks. Each zone is a completely closed system.

Heater bands are mounted around the steel jackets.

Each cylinder section is filled with a liquid heat transfer medium, which has a relatively flat vapor pressure vs. temperature range curve (water for temperatures up to 465° F and Dowtherm A for temperatures from 350° to 700° F are used), and, upon initial heat-up, the system is vented to remove air and noncondensable gases.

OPERATION AND COMPARISON

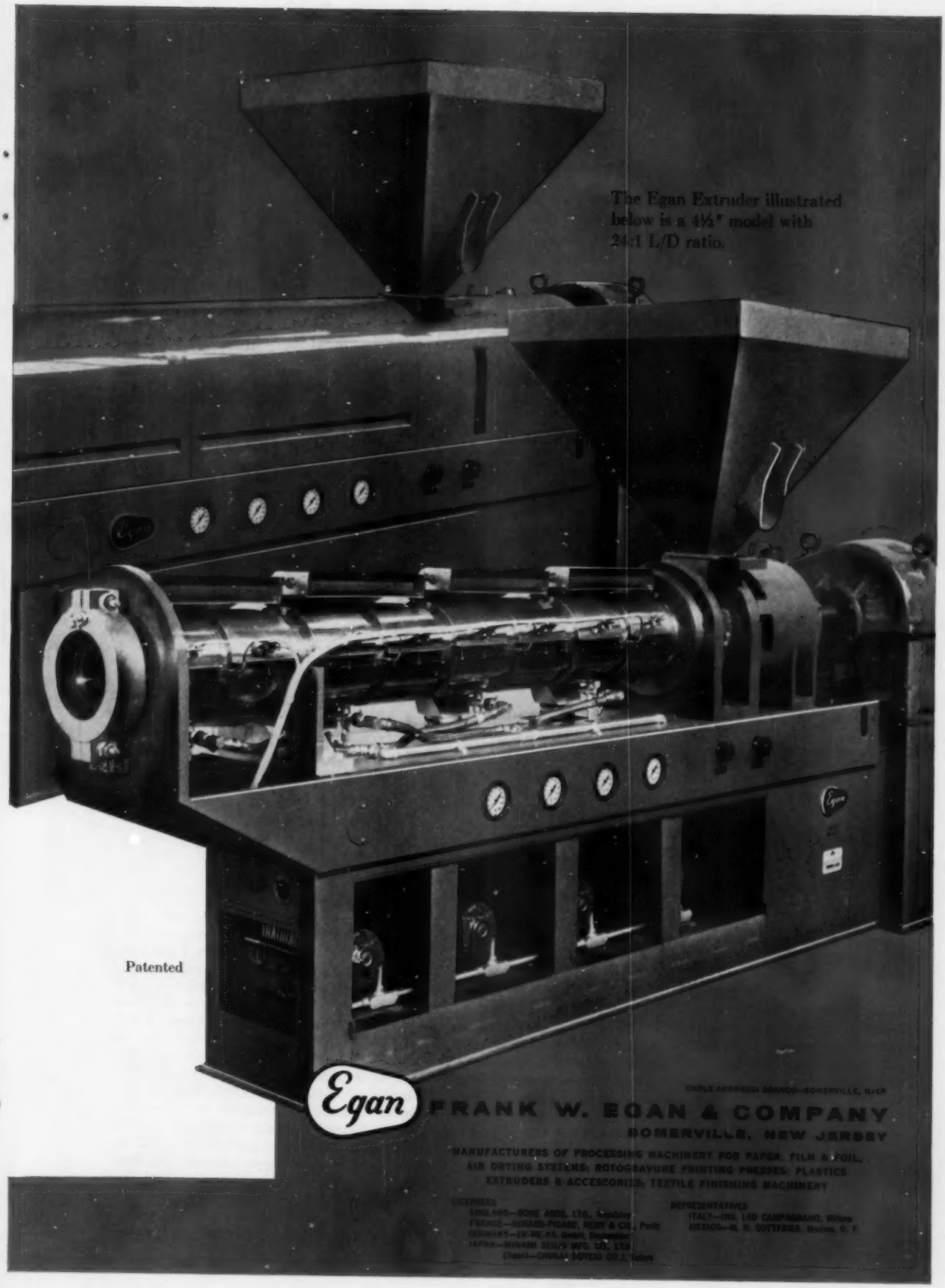
As the cylinder is heated, a vapor pressure, corresponding to the temperature of the cylinder or the heat transfer medium is maintained within the pressure chamber. The liquid will not boil as long as this pressure is maintained.

If cooling is required, due to a build-up of frictional heat or possibly due to a desire to lower the temperature in the zone, the thermocouple, which is located in the cylinder close to the liner, senses the excessive heat, and activates the blower. This, in turn, condenses some of the vapor, reduces the pressure and thus the liquid in the jacket begins to boil. The condensate returns to the bottom of the cylinder, setting up a circulating system.

Since only the latent heat of vaporization is removed, the vapor and the condensate are of essentially the same temperature; consequently, the control is gradual, producing no shock cooling to the cylinder, but removing the excessive heat most efficiently. The design of the jacket is such that the cooling takes place over the full length and full circumference of each zone, thereby eliminating any possibility of thermal distortion. There are no hot or cold spots.

SUMMARY OF ADVANTAGES

1. Completely automatic.
2. Completely self-contained.
3. No manually operated valves or switches.
4. Heating or cooling is uniform over full length and circumference of each zone.



The Egan Extruder illustrated below is a 4½" model with 24:1 L/D ratio.

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EXTRUDERS & ACCESSORIES; TEXTILE FINISHING MACHINERY

Foam-insulated panels

Pre-insulated inside wall panels—based on the use of expandable styrene foam slabs—are now available as snap-in liners for metal building panels used in the construction of factories, warehouses, and offices.

The plastic foam panels (with a zinc-coated steel skin) were recently announced by Armco Drainage & Metal Products, subsidiary of Armco Steel Corp., Middletown, Ohio. They are designed to the same 16-in. module as the company's exterior panels. Together, the two panels result in an extremely efficient finished wall from the standpoint of heat loss; an overall heat transfer coefficient of 0.16 for the panels is claimed by the company. This, of course, results in lower costs for equipment and fuel needed to heat the house.

The photograph shown below illustrates how the interior and exterior panels are combined to form the finished, insulated curtain wall. Liner panels are applied by snapping them

STYRENE FOAM insulated liners (top) snap into place in metal building panels (shown at bottom).

in against a gasket strip of extruded Geon (B. F. Goodrich) elastomeric vinyl (not shown in photo) which is compressed between the outer panel rib and the liner flange. Pressure from the vinyl strip secures the liner panel and keeps it from moving in or out; the flange interlock prevents the panels from moving laterally. The vinyl extrusion also provides a thermal break. Base and window trim complete installation of the liner panels.

The 1-in.-thick styrene foam slabs used to insulate the panels are produced by Dyfoam Corp., New Castle, Pa., using Dow and Koppers expandable styrene beads. In manufacturing the panels, Armco first sprays EC 321 adhesive (Minnesota Mining & Mfg. Co.) on the steel sheets, then passes the sheets through a continuous oven to drive off water. The foam insulation is next placed in the panel and the assembly subjected to pressure of approximately 15 p.s.i. to insure a good bond.

Single-component epoxy encapsulation

Electrical and electronic parts of almost any shape and size can now be encapsulated in transparent, but amber-colored, epoxy resin with a minimum of preparation and trouble. This is made possible by a new single-component, unfilled resin which need only be heated and poured; no catalysts or other additional components are required.

The new resin, called Maraset epoxy casting powder #135E and offered by Marblette Corp., Long Island City, N. Y., is reported to meet transformer specifications of MIL-T-27A and to permit continuous operation in the H Temperature class. The cured resin adheres firmly to encapsulated parts, has a reported Izod impact strength of 0.7 ft.-lb./in. of notch, volume resistivity of 5×10^{12} ohms/cm., and a Shore A hardness of 90; shrinkage during cure is listed at only 0.015 in./in., usually considered negligible for encapsulation applications.

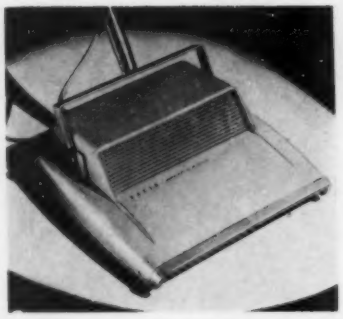
In use, the single-component resin powder is heated to 120° C., with constant stirring. At the same time, the mold, coated with release agent is also heated to 120° C.; however, the temperature is not critical; it can range upward to 125° as a maximum.

The powder liquefies rapidly under heat, and the parts to be protected are impregnated either by dipping or pouring the resin over them in the pre-heated mold. Final cure takes place in an oven at 125° C. for 12 hours. Once the resin has been melted, its pot life at 110° C. is reported to be 4 hours.

New look in RP panels

Leaded glass that is neither lead nor glass is the latest twist in the line of reinforced plastics panels produced by Barclite Corp. of America, New York, N. Y. These panels, available in green or translucent clear, measure 24 by 96 in., and are suggested in decorative applications where true leaded glass was formerly used, *viz:* screens, room dividers, doors, tops for lawn or porch furniture, breakfronts, shower stalls, and tub enclosures.

The "lead" effect is obtained by embedding steel strips in the reinforced plastics laminate prior to molding.



Phenolic-housed carpet cleaner

Because of the possibilities it offered for more elaborate design and quieter operation, compression-molded phenolic was selected for the housing for a new carpet cleaner recently announced by Davis Mfg. Co., Plano, Ill. This new version of the old-fashioned carpet sweeper, has all the advantages—*plus*—of its forerunner. It is light in weight and easy to operate.

The housing of the cleaner is molded of Durez 791 phenolic compound supplied by Hooker Chemical Corp., Niagara Falls, N. Y. The compound was chosen to meet rigid requirements of maximum molding performance at minimum cost. The compound is also stated to provide a smooth surface finish with no flow lines;.this surface has proved ideal as a base for subsequent finishing with a special phenolic enamel which is sprayed on and then baked. Four colors—beige, gray, pink, and green —are offered.

The handle shaft of the cleaner is topped with a contoured vinyl grip manufactured for Davis by The Ohio Rubber Co., Willoughby, Ohio. Retail list price of the cleaner, known as Sweep O Matic, is $19.95.

PE shelf lining

Rotogravure-printed, 3.5-mil polyethylene film has been introduced by Ullman Co., Brooklyn, N. Y., as combination shelving-edging material. According to Ullman, the film is sufficiently strong and tough to withstand even severe service conditions; it will hug shelves without tacks, tape, or adhesive. Designated Shelflex, the shelf-lining is supplied in rolls 13¾ in. wide, 12 or 25 ft. long. A precreased edging line allows for simpler, straight folding. Retail price is 98¢ for the 12-ft. roll; $1.98 for the 25-ft. length. Shelflex is based on Polyfilm, supplied by The Dow Chemical Co. Five patterns and 24 colors are currently offered. Keep your eyes on this application—shelf linings are becoming big business for PE.

(More on page 165)

KNIFE SHARPENER ATTACHMENT

CYCOLAC®

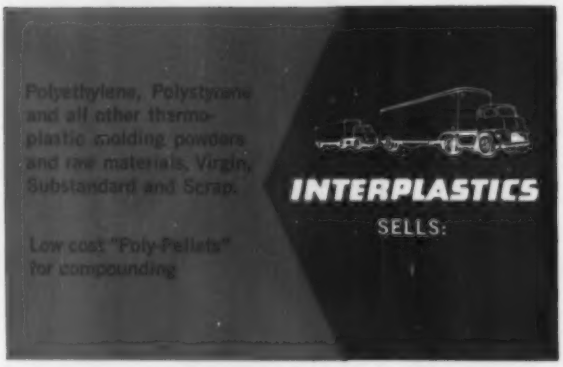
THE BORG-WARNER PLASTIC THAT'S TOUGH, HARD, AND RIGID

This smartly styled General Electric Portable Mixer had to have a housing with complete dimensional stability, had to ignore food and juice stains, resist kitchen marring and scarring—yet be light enough to keep the mixer's weight at only 2¾ lbs. That's why G.E. engineers specified CYCOLAC—the ABS plastic from Borg-Warner—for both housing and handle.

The unique balance of properties offered by CYCOLAC provides ever-increasing opportunities for outstanding improvement in electrical appliance design, engineering, production—and most important—performance. For your product, too, this remarkable plastic may well open the way to new competitive advantage.

Investigate . . . write Dept. C-1 for details.

MARBON CHEMICAL WASHINGTON — MARBON B-W CHEMICAL — DIVISION **BORG-WARNER** WEST VIRGINIA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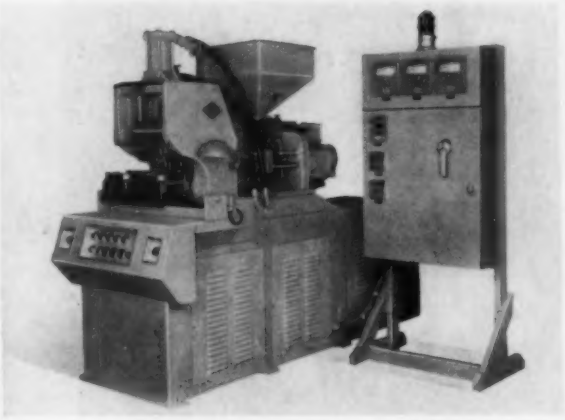

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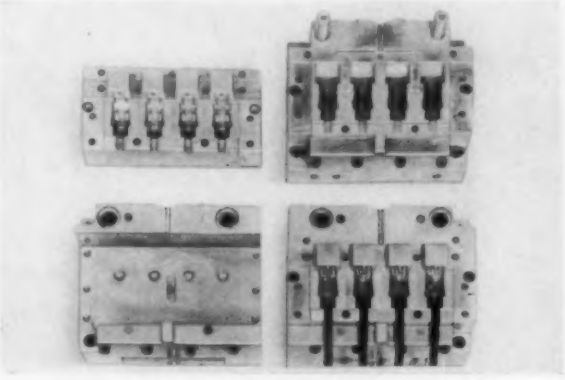

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 (From page 162)

Decorative laminates

A fabric laminating technique that opens the door to new design concepts in decorative plastic laminates for short-run furniture and panelboard production has been developed by Food Machinery & Chemical Corp., New York, N. Y. This development is a direct outgrowth of FMC's Daponite laminating system which was introduced earlier this year (see "New competitor for decorative laminates: DAP," MPI, Aug. 1960, p. 90).

The furniture manufacturer's choice of fabric patterns can come from a virtually unlimited range of existing materials, but his selection of decorative papers is limited to the special printed papers impregnated by custom satuators. Now, however, the manufacturer can easily create his own individualistic line by incorporating fabric laminates and, because the fabrics can be saturated at his own plant, can produce specialty pieces without making volume commitments.

The actual laminating can be done on most types of hot presses after modifications are made. This equipment already exists at many furniture plants. The new laminate can be produced at pressures ranging from 100 to 250 p.s.i. (Other plastic surfaces require laminating pressures as high as 1000 p.s.i.)

. . . And in brief

• Portable laboratory unit for field-testing water throughout the world uses Westinghouse Micarta decorative laminate for the exterior surface. Developed by General Ionics Corp., Pittsburgh, Pa., the 15¼- by 9¼- by 10¾-in. carrying case is fabricated by Drechsler Cabinet Co., Elizabeth, Pa., and consists of a laminate-wood sandwich 9/16 in. thick. The sandwich is composed of a 1/32-in. laminate on either side of a ½-in. plywood core. The edges are sealed with flat-finish laminate. All plastic is procured through United States Plywood.

• Piston rings made of Duroid 5813, a Teflon reinforced with glass microfiber produced by Rogers Corp., Rogers, Conn., were specified for the check valve used in the engine air system made by the Janitrol Aircraft Div., Midland-Ross Corp., Columbus, Ohio, for jet engine starting. The valve operates in a temperature environment of 570° F. ±25° F. at 145 p.s.i.

• Speaker housing of Fiberglas-reinforced polyester resin for use in drive-in theaters has been announced by Eprad Inc., Toledo, Ohio.

• A diallyl isophthalate housing for the 500 Series potentiometer made by Spectrol Electronics Corp., San Gabriel, Calif., increases the operable temperature range of the instrument to 500° F., up to 100° higher than standard diallyl phthalate. The housing is transfer molded in a one-shot press of Spectrol's own make. Mesa Plastics Co., Los Angeles, Calif., supplies the fibrous glass-filled molding compound, which is based on Dapon M resin from Food Machinery & Chemical Corp., New York, N. Y.

• The pounding shock of the arresting gear that halts planes on the decks of the U. S. Navy's Independence and Saratoga now is cushioned by pads of polyurethane developed by B. F. Goodrich Industrial Products Co. Vulcanized to quarter-inch steel plate, this polyurethane material provides a higher tensile strength and 8 to 10 times the abrasion resistance of the best available rubber.

• Disposable shower caps, especially suited for use by hotels, motels, etc., are fabricated of polyethylene film by Thermo-Flex Corp. of California, Menlo Park, Calif. Price of caps is $67.50 per thousand, in lots of 50,000 to 100,000, slightly higher in smaller quantities.

• Time required to get ready and clean up in the spray painting of automotive finishes has been reduced by new polyethylene film wheel covers designed by Martin-Senour Paint Co. Covers are fabricated by Central States Paper & Bag Co., St. Louis, Mo., of film made from Bakelite polyethylene.—*End*

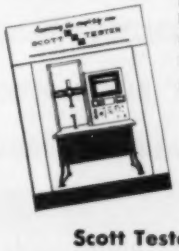
THE SURE TEST . . . SCOTT!

NEW PUSH-BUTTON CONTROL SIMPLIFIES PHYSICAL TESTING

THE SCOTT MODEL CRE Constant-Rate-of-Extension Tester offers you the ultra-high accuracy of inertialess electronic weighing . . . *plus* effortless automatic operation that takes the work and weight handling out of physical testing! At a touch, the simple finger-tip controls of the Model CRE provide a variety of crosshead speeds, complete crosshead control and a wide range of test capacities . . . enabling even the non-technical operator to obtain detailed test results faster, easier, and *at amazingly low cost!*

VERSATILITY is another time-and money-saving feature of the Scott CRE Tester. This simple yet super-sensitive tester is designed for use with Scott's more than 150 different clamps and holding fixtures to meet ASTM, ISO and Industry Test Methods and material requirements. Moreover, Model CRE can be set up quickly for tensile, tear, adhesion, burst, seam construction and many other physical tests . . . with ranges from the lowest up to 1000 lbs. or 500 kgs.

FOR PRODUCT DEVELOPMENT, QUALITY CONTROL, and countless other tests that make the difference between profit and loss . . . you can be sure *your* product's qualities meet industry standards, when you make the sure test . . . Scott!



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SCOTT TESTERS
THE SURE TEST . . . SCOTT!

Polyethylene

(From pp. 84-91)

appointment in 1960 was particularly keen, since several fairly new applications were thought to be ready to "take off," and 1959 had shown an increase of some 70 or 80 million lb. over 1958.

For example, the use of polyethylene film in produce packaging may have declined from 70 million lb. in 1959 to 60 million in 1960; part of this decline came from competition with other films. Textile packaging, which may have used 40 million lb. in 1959, was down several million. Garment bag use was off by several million pounds.

On the other hand, the use of film for bakery goods is thought to have grown from 7 million lb. in 1959 to about 14 million in 1960. But there is still a vast, untapped volume for this application. The potential for film in the baking industry is estimated at around 90 million lb. of 1-mil film.

Tobacco companies are now having another look at polyethylene for cigarette wrappers—despite their earlier rejections of the film. A coating on the PE may lessen the fear of flavor-loss and aid the sealing problem on wrapping machines. Just capturing a portion of this market could mean 10 or 20 million lb. for polyethylene. But film producers realize this is one of those very-hard-sell propositions.

The applications described above are indicative of the task facing the polyethylene film packaging industry in developing additional sales volume. There are various other applications which are being kept under cover for the time being. Yet the time may not be far distant when new pickings will get slim and the industry will have to depend on natural economic growth instead of developing new uses.

There are, of course, large potential areas of growth in other film fields. Agricultural uses have grown very slowly and may not pick up great volume for several years. It is expected that these may start booming about 1965. The use of film-lined trench silos hasn't grown as expected, but ex-Secretary of Agriculture Claude Wickard has been quoted as saying it's the greatest invention since the wheel.

Use of polyethylene film for greenhouses is increasing, especially on the part of farmers who raise vegetables for the winter market. Large acreage is already under cover for this purpose. Weatherable film has been a great aid in promoting the greenhouse application. However, methods of fastening film on the frame have not yet proved entirely satisfactory.

Other farm potentials for film applications are temporary shelters, windbreaks, tarpaulins under fruit trees for harvesting the crop, wrapped fruit, tank linings for mixing insecticides, canal and pond lining, irrigation ditches, frost protection, and rice paddy lining. Imposing list, isn't it?

USE OF FILM IN CONSTRUCTION has been about the same for several years but ought to grow. A fairly new application that looks big is its use as a moisture barrier on the warm side of walls to prevent moisture collection in the fibrous insulation. Biggest **(To page 171)**

YOUR ASSURANCE OF THE HIGHEST UNIFORM PERFORMANCE

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ORGANIC PEROXIDES

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TERTIARY BUTYL HYDROPEROXIDE

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Write NOW! A local McKesson & Robbins Chemical Department representative will be pleased to call and talk over your Organic Peroxide requirements.

U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

Packaging Notes

Disposable aprons of polyethylene-coated perforated and embossed paper were tested in the galleys of a rig by an offshore oil drill company to determine their utility. The aprons are said to protect against grease spatterings, and withstand the normal soiling encountered in meal preparation. The expense of handling and transporting soiled cloth aprons back to the mainland and laundry costs are eliminated by the disposable apron.

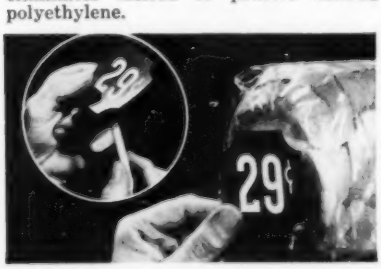
Storage drums of conventional polyethylene, accepted by FDA for use with foods, can now be obtained in 20-, 32- and 55-gallon sizes with or without dust covers. Air-tight polyethylene covers and steel closure rings are available for the 55-gallon size, also.

According to the manufacturer, drums are clean, white, lightweight and quiet; have excellent impact resistance; nest for storage; will handle most jobs of stainless steel drums, yet cost less. Other applications include storing supplies, emergency water, sterile linens and clothing, and chemicals.

One-Gallon Jug fabricated of conventional polyethylene has pouring spout set off-center to allow a large carrying handle on top. A tail on the handle permits using the little finger to get a tighter hold.

According to the producer, this redesigned jug, which is the same price as a previous model made by the company, has a stronger spout and body and is more stable. Closures are claimed to be skip-proof and leak-proof.

New end label for polyethylene bread wrap claimed to have exceptional adhesive qualities requires only moderate heat for positive closure. The coating is activated at approximately 150°F. which is 40° lower than the temperature needed by most other heat-activated end labels. (The heat from a cigarette is said to be sufficient.) This quick-melt coating eliminates melted or pinhole burned polyethylene.



U.S.I. Sees Usage of Polyethylene Up 10 Per Cent In 1961

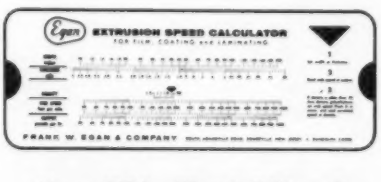
Increases Anticipated in Many Market Areas

"In 1961, polyethylene will regain much of the sales momentum that characterized its dynamic growth in the late 1950's," forecasts Vincent D. McCarthy, Director of Plastic Sales of the U.S. Industrial Chemicals Co.

Sports Megaphones Injection Molded Of Polyethylene

Megaphones for sports fans are being injection molded of a U.S.I. PETROTHENE polyethylene resin by an Ohio firm. According to the company, PETROTHENE 208 resin was chosen because of its uniformity, and because it provides good gloss and durability, flows better than competitive materials, and gives better than average results with dry coloring.

Available in a variety of colors with contrasting hot-stamped collegiate emblems, the megaphones are reported to withstand constant squeezing and handling and a wide range of weather conditions.



Free Slide Chart Offered

A handy extrusion speed calculator for film, coating and laminating is available from a manufacturer of extrusion coaters. With this slide rule, the extrusion capacity required for a specific web speed, width and coating thickness can be quickly determined.

Polyethylene film will be a leading factor in increasing polyethylene usage by 10% in 1961, according to Vincent D. McCarthy, U.S.I.'s Director of Plastics Sales.

U.S.I., manufacturer of PETROTHENE resins, is the world's second largest producer of polyethylene.

Mr. McCarthy predicts a rise in usage approaching 10% for 1961, indicating that a number of fast-growing markets will make it possible.

The demand for film and sheeting of conventional polyethylene, for example, is expected to increase to 465 million lbs. in 1961 compared with the 400 million lbs. used last year. Spurred by wider use of inplant automatic polyethylene packaging equipment, this material has made steady inroads in breadwrap, produce, textile, and other fields. Automatic equipment in use is typified by the See-Safe machine, with which even outsize products such as card tables and bolts of cloth can be custom-packaged efficiently in polyethylene.

Additional conventional polyethylene, perhaps as much as 75 million lbs., can be expected to go into coating this year. Polyethylene coated milk cartons will lead the growth in the fast moving extrusion coating fields.

Blow Molding To Gain

According to Mr. McCarthy, blow molding, now a 50-million lbs.-per-year market, will climb faster in '61 and eventually rank with injection molding (now consuming 250 million lbs. of conventional polyethylene yearly). He sees a shift developing from low-density to medium-density polyethylene in this field, but feels the 1961 sales upturn will be shared by linear polyethylene.

Pipe and wire and cable insulation are among other markets for conventional polyethylene which are each expected to contribute an increase of about 5% in usage to the '61 sales picture.

NOW...VIRGIN FOR INJECTION 26¢/ DIRECT FROM

U.S.I. Sets Record Low Price for Virgin PETROTHENE® Polyethylene Resins With Melt Index and Flow Properties Designed For Injection Molding Toys, Housewares, Novelties.

There's no doubt that 26¢ is an attractive price for injection molding polyethylene resin. But it takes more than just a low price tag to make a bargain.

U.S.I.'s new PETROTHENE polyethylene resins are good buys at 26¢ because you get quality virgin injection molding resins with well-defined properties . . . you are dealing directly with the producer . . . and the producer – well-known and long-established – puts his reputation behind the resins.

YOU GET QUALITY. PETROTHENE 117 and 213 polyethylene are virgin resins developed exclusively for injection molding applications – housewares, toys, novelties.

PETROTHENE 117 produces moldings of good appearance, extreme toughness and high gloss. Molded items have a low to medium stiffness.

PETROTHENE 213 is recommended where greater stiffness is desired. Molded items have excellent appearance, good toughness and very high gloss.

YOU GET VIRGIN RESINS. PETROTHENE 117 and 213 polyethylene resins are pure, unreprocessed materials which you can purchase only from the manufacturer – U.S. Industrial Chemicals Co. Their properties, shown in the accompanying table, are clearly defined.

TOPS FOR INJECTION MOLDING. Both PETROTHENE 117 and 213, with desirable melt index of 8.0, are high flow polyethylenes. You can operate on short cycles and achieve high economical rates. If you mold colored items, you'll find both resins easy to pigment by either dry blending or homogenizing.

YOU DEAL WITH A WELL-KNOWN MANUFACTURER. U.S. Industrial Chemicals Co., a prime manufacturer of polyethylene resins, is the world's second largest producer of this important plastic. U.S.I. conducts an extensive program of basic and application research on polyethylene. As a result, the company is continuously developing new resins with superior properties and improving application processes for these materials.

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	Density	Melt Index	Characteristics of Moldings			
	g/cu cm	g/10 min.	Appearance	Toughness	Gloss	Stiffness
PETROTHENE 117	.917	8.0	good	extreme	high	low to medium
PETROTHENE 213	.923	8.0	excellent	good	very high	medium to high

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POLYETHYLENE PROCESSING TIPS

Series VI, No. 1

HOW TO DETERMINE OPTIMUM BLOW-UP RATIO

In blown film extrusion, blow-up ratio is the ratio of the diameter of the film "bubble" to the diameter of the extruder die. It's much easier to measure the width of the lay-flat tube after it has passed through the nip rolls than the diameter of the inflated bubble. And since the two are related by simple geometry, blow-up ratio can be calculated easily from the formula:

$$\text{Blow-up ratio} = 0.637 \times \frac{\text{lay-flat width}}{\text{die diameter}}$$

The best possible balance of film properties for a given polyethylene resin can be obtained with a 2:1 to 2.5:1 blow-up ratio. This recommendation is based on studies at U.S.I.'s Polymer Service Laboratories, combined with field experience of U.S.I.'s Technical Service Engineers.

Effect on Specific Film Properties

In the U.S.I. studies, six general-purpose film-grade polyethylene resins were extruded under comparable conditions at blow-up ratios of 1:1, 1.5:1, 2:1, 2.5:1, 3:1, and 3.5:1. The properties of these resins varied over a rather wide range. Yet, as blow-up ratio was increased, the effect on specific properties was similar for all six resins:

Transmittance increased 12 to 16 units (Fig. 1). PETROTHENE® 112, for example, had a 60% transmittance at 1:1 blow-up ratio and 72% transmittance at 3.5:1.

Gloss, measured at a 60° angle, increased 1.2 to 2.5 units (Fig. 2). The average was 7.1% at 1:1 blow-up ratio and 9.3% at 3:1.

Haze decreased significantly (Fig. 3). Average decrease was 3.5 to 4.5 units.

Impact strength improved (Fig. 4).

FIGURE 1

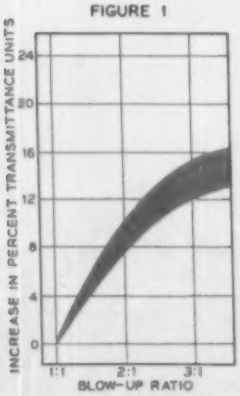
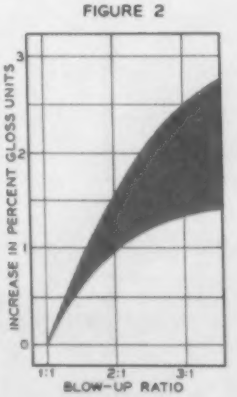


FIGURE 2



While these tests seem to indicate 3:1 or higher as an optimum blow-up ratio, this is not the case. Note how other essential properties are affected by an increase in blow-up ratio:

Straight line tear, the tendency of film to tear in a straight line, is reduced significantly.

Elmendorf tear strength decreases significantly above a 2:1 blow-up ratio.

Yield strength decreases slightly.

Break point increases in the transverse direction and decreases in the machine direction.

Tendency to wrinkle may be a serious problem above a 2.5:1 blow-up ratio.

How To Increase Blow-Up Ratio

Because film lay-flat width is almost always predetermined, blow-up ratio is ordinarily increased by using a smaller die diameter. True, this results in a slight decrease in output; however, increasing screw speed will usually compensate for most of this decrease.

What Blow-Up Ratio Should You Use?

Extruders now producing blown film at a blow-up ratio below 2:1 should consider increasing it if they desire improved optical properties and higher impact strength. Also, companies entering the field should consider blow-up ratio before deciding which size dies to buy.

Of course, other factors may be involved. If you have questions on specific problems, we suggest you seek advice from U.S.I. Technical Service Engineers.

FIGURE 3

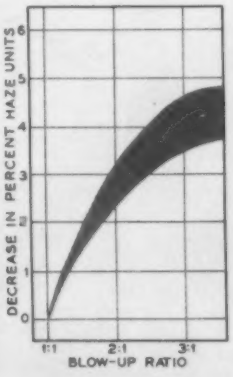
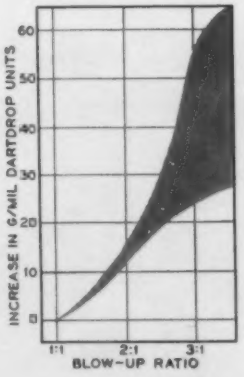


FIGURE 4



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use today is under concrete slabs. It is also used for protection of construction, workers, and materials during a building operation, between flooring, on crawl space, in storm windows, and as pipe wrap.

Two unusual developments in film last year deserve mention. The first was an irradiated film with upgraded properties in almost every category. It has not yet been out long enough in the market to estimate its future. The other was a so-called "2-in-1" film (combining clarity and strength in one film) that sells at a few cents a pound above conventional film. The producer asserts that, heretofore, one of these properties always had to be sacrificed at the expense of the other. It is now being used for wrapping shirts, sheets, pillow cases, and produce.

The use of coating resins on paper and foil is growing even faster than the 1960 poundage figures show, for the thickness of the coating has been dropped from a mil or so to less than ½ mil in many cases. This was supposed to be one of the areas that would show the greatest consumption increase after the 5¢ price break in resin; it would bring the coated material into price ranges of other competing products. The biggest potential is thought to be in coated board for milk containers, which could use from 90 to 110 million lb. by 1965.

Polyethylene-coated cellophane is growing nicely and is used primarily for wrapping luncheon meats, dry soups, and other hygroscopic products. Polyethylene-coated Mylar is found mostly in boilable pouch containers.

The poundage shown for injection molding in the table on page 86 is another uncertain figure because so much of it is off-grade and reprocessed material. Chief end-uses are housewares and toys, as mentioned in the earlier discussion on linear polyethylene. There were no particularly new developments in this field in 1960 nor any indication that any new products were coming along other than different varieties and styles of those now in use.

The other classifications in the table were either discussed under linear polyethylene or speak for themselves.—*End*

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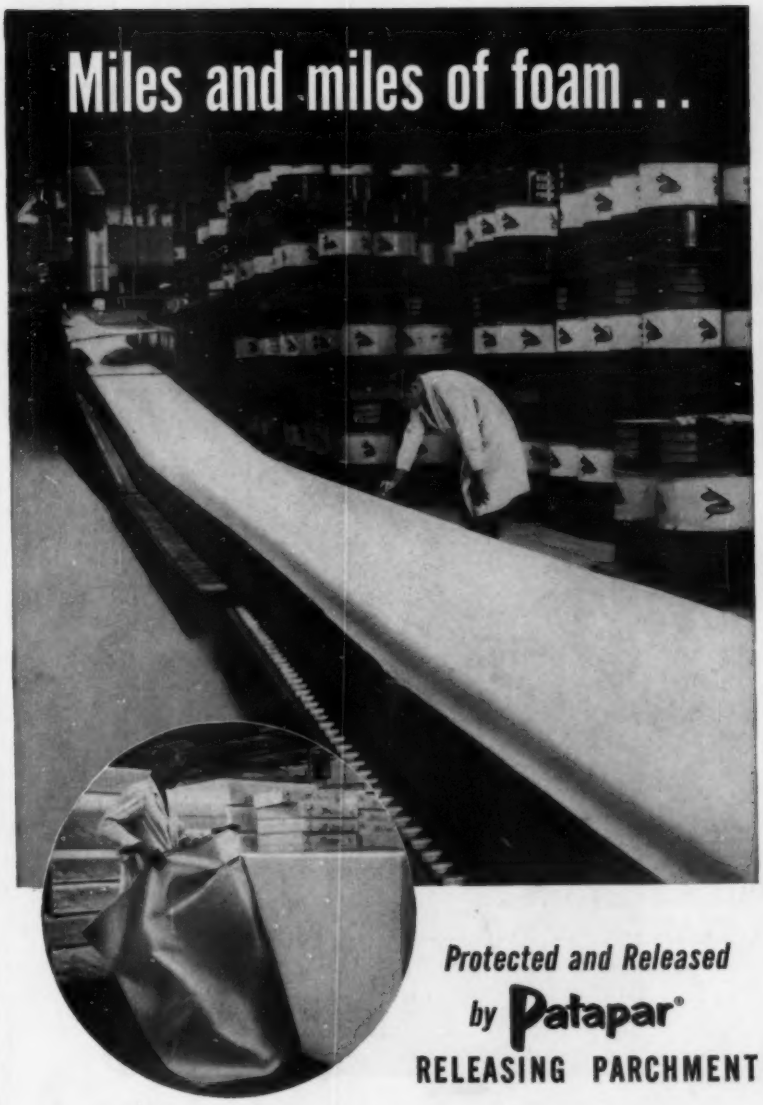

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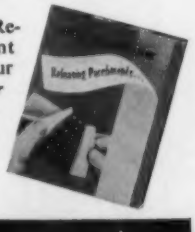

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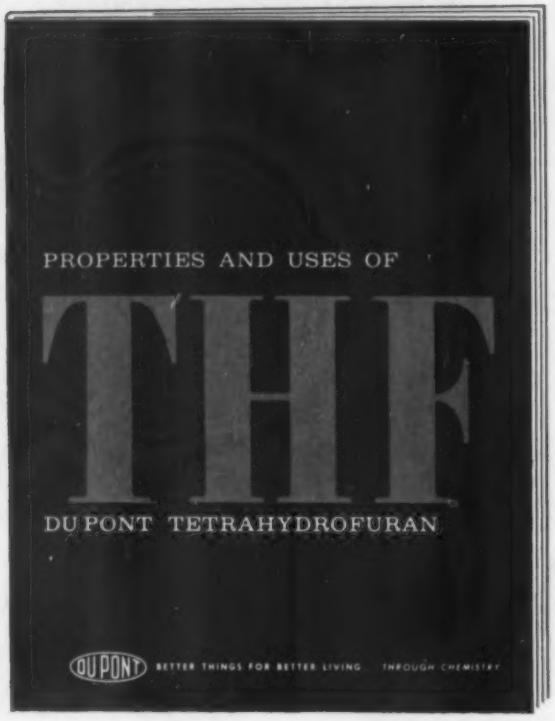

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Polypropylene

(From page 91)

investment bankers to a fever pitch of excitement. However, they may cool off when they study the costs involved in building a plant and the development-of-markets cost in creating a 500-million-lb. market for the material in 5 years. Premature excess capacity is an avaricious consumer of money for those who are not "well-heeled" enough to withstand the pressure.

It may come as a shock to some members of the plastics industry to learn that many informed specialists in polypropylene are now of the belief that more polypropylene will eventually be consumed in textile manufacturing than in either plastics products or film production. The old theory was that the three would be divided about equally. But the present opinion seems to be that textiles look most promising. A fabric made of polypropylene filaments barely supports combustion; fabrics woven 100% of polypropylene can be made to appear like wool; and fiber blends of cotton with up to 65% of polypropylene filaments show much promise. Technicians believe that a low-cost, efficient system for dyeing polypropylene fabrics will be worked out eventually. At present, it is still a problem, just as it was for all other synthetic fabrics when they were first introduced. However, a long period of evaluation is generally involved before a new fabric is widely accepted. For the would-be producer, facing the judgment of merchants who must pass on such fabric qualities as "hand," drape, appearance, etc., it is akin to running the gantlet. The polypropylene producers believe they will be able to run this gantlet without much damage.

Consumption of polypropylene for all purposes, including experimental evaluation, in 1960 was estimated at from 35 to 40 million pounds. Estimators are now talking about 80 to 100 million lb. in 1961, and over 150 million in 1962.

Almost one-third of the 1960 output went into filaments for seat covers, rope, and the like. Very little has yet gone for yarn, since the manufacturing process involves equipment not yet commercial. From 2 to 2½ million lb. was used

for rope. It is possible that within two years there will be more polypropylene rope than nylon rope on the market, and the latter has been around for many years. However, polypropylene rope is essentially designed to supersede manila rope rather than nylon. Polypropylene offers durability, strength, and light weight. One man can handle as much propylene rope as three men can handle manila—a propylene rope need be only one-third the diameter of a manila hawser to do the same job.

However, the total market for propylene rope is estimated at no more than 7 or 8 million pounds. If the monofilaments can be converted to twine or thread, the market will be much larger. The bulk of the monofilament output in 1960 was for webbing used in seat covers. Filaments are also used in the bristles for tough, resilient, and long-wearing industrial brushes.

Molded polypropylene made good progress last year. Probably the most sensational item was the Sears, Roebuck luggage case which contained 5 lb. of what is the lightest-weight plastic in commercial production. The luggage shells are probably close to being the largest single shot in polypropylene molded applications to date. The luggage is produced from a high melt-index resin that is resilient, tough, resumes shape after denting, is scuff-resistant or can be sandpapered to remove scuff if it happens, and is easily cleanable inside and out.

Once the tooling is paid for, it is a low-cost case. Sears has shipped cases over 500,000 miles to test performance, especially under severe winter conditions—and they outlasted all other types of luggage! The cases have been thoroughly tested as to endurance at —40° F. temperature. The mold was specially built with gating that would eliminate residual strains.

Another large polypropylene piece on the way is the back for a 19-in. television cabinet. Radio cabinets of polypropylene are also on the market.

Still another large 5-lb. piece is a tote box used in machinery plants for carrying various heavy metal parts from one station to another.

Another unique feature of polypropylene is its great flexibility; this permits molding of integral or

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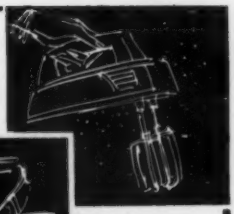

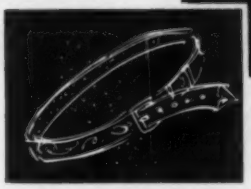

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built-in hinges into a given product. A one-piece eyeglass case was one of the first products to take advantage of the integral hinge idea. Other hinged items include napkin dispensers, air conditioner louvres, a carrying case for miniature sewing machines (the more the hinge is flexed in this application, the easier it opens), auto air conditioners with a filter-strip holder hinged to the conditioner frame, hinged lids on coffee pots, hinges on toilet seats to replace easily-corroded metal, and small carrying cases.

Other molded or extruded products introduced last year included the arm in a Waste King dishwasher column through which hot water and detergents are pumped, vacuum bottles, bank notebook covers, a threaded boat hydrant with a 5/32-in. wall section, occasional dinnerware, valves, pipe fittings, spray containers, and even a test squeeze tube for pharmaceuticals, glue, etc., which is impermeable to essential oils, is heat-resistant, and is functional even in thin wall sections.

In automobiles, polypropylene is being both evaluated and used for dome lights, cable connectors, steering wheels, seat kick panels, and other applications. It was estimated that use in 1960 models averaged ¾ lb. a car—increasing to about 1½ lb. in 1961 cars. Possible use in refrigerator applications is also being investigated.

Producers in the polypropylene industry are vigorously promoting its use as a replacement for die cast metals. They point out its light weight; its specific gravity is 0.90, compared with other plastics that go up to 1.42 and with zinc at 6.6. Polypropylene weighs but 0.033 lb./cu. in., compared with 0.096 lb. for aluminum and 0.238 lb. for zinc. In comparing note that a 1-in.-thick sheet of polypropylene will provide stiffness equal to 0.305-in. zinc. Take into account the costly metal fabricating and finishing operations that are eliminated when you mold the polypropylene product in one piece—and you can see that the plastic offers economic advantages.

Some of the advantageous physical properties of polypropylene as a molding or extrusion material are light weight, flex strength, resistance to heat distortion up to 250° F. under 40 lb. service pressure, impermeability, stiffness, and good service. Like any other plastic, it also has properties that must be guarded against. Low temperature resistance is one, but this can be avoided by building a properly-gated mold designed to avoid stress or strains. Creep can also be guarded against by proper mold design. In general, molds should be designed especially for polypropylene's unique properties in order to avoid problems. The greatest handicap to the material thus far is probably the 42¢/lb. price, but that will decline as volume increases.

There are now various formulations available to meet demands of different applications. One company offers six different melt flow ranges: general-purpose injection molding, general-purpose extrusion, high melt flow grade, film grade, low melt flow grade, and extra-low melt flow grade. All producers now have at least four grades.

Stabilization, too, is a most important factor in use of polypropyl-

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ene, since it will oxidize rapidly unless a carefully adjusted stabilizing system is used. Such systems in polypropylene are varied according to the end product. Hercules has at least six different varieties. If the product must withstand long periods of heat, as in television components, a certain stabilizer is used; rope for outdoor use requires another type of stabilizer, a food container will require still a third type that would be non-toxic. Depending on what type of stabilizer is selected, there may be some sacrifice in properties called for; the user must be prepared to balance the differences.

In this connection it should be noted that Hercules was the first company to receive the government's FDA approval for use of a special non-toxic polypropylene formulation for food containers. This approval does not apply to all polypropylene formulations.

Progress in development of polypropylene film in 1960 was only fair. A biaxially oriented film with a thin coating was announced by one film producer, but sales thus far have been low. Development of unoriented film is still in a state of uncertainty, although there is every reason to believe that it will yet fulfill the producers' optimistic outlook. Problems in production have not yet been completely overcome, and sales problems, such as meeting competition from other films, and running PP film on conventional packaging or wrapping machines, are tough nuts to crack. Yet small quantities of satisfactory film have been used—some of it for bread wrappers and for paper products such as typewriter carbon paper. It is used because of long shelf life, gloss, clarity and feel—all of which are properties that compete on a favorable basis with other film. Furthermore, its strength is such that a 1-mil-thick polypropylene film is said to give as much strength as a 1¼-mil polyethylene film. At 70¢/lb. for a 1-mil film, polypropylene is claimed to be less costly on a yield basis than 62¢/lb. cellophane. Despite its delay in getting to market in a big way it is certain that producers and processors of other films are keeping their eyes on polypropylene film lest it suddenly walk into the markets where big volume is the prize.—*End*

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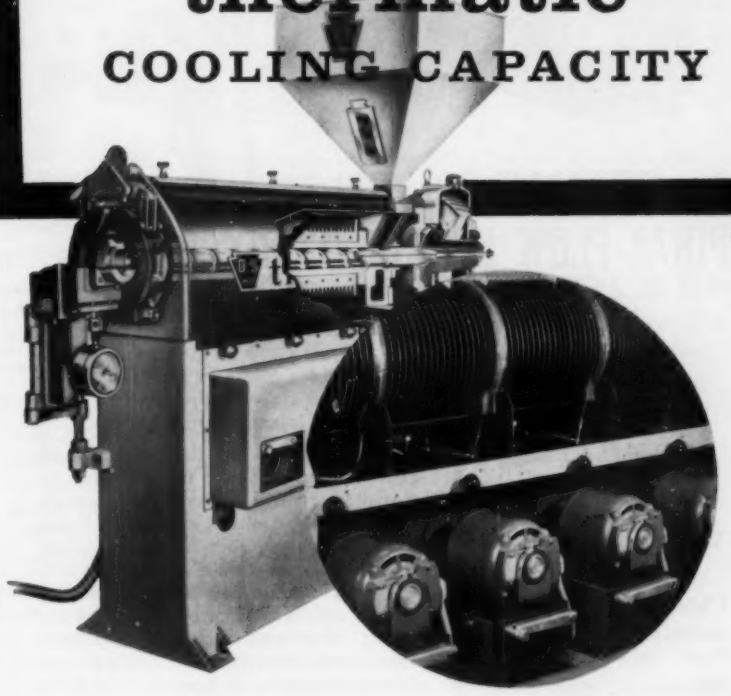

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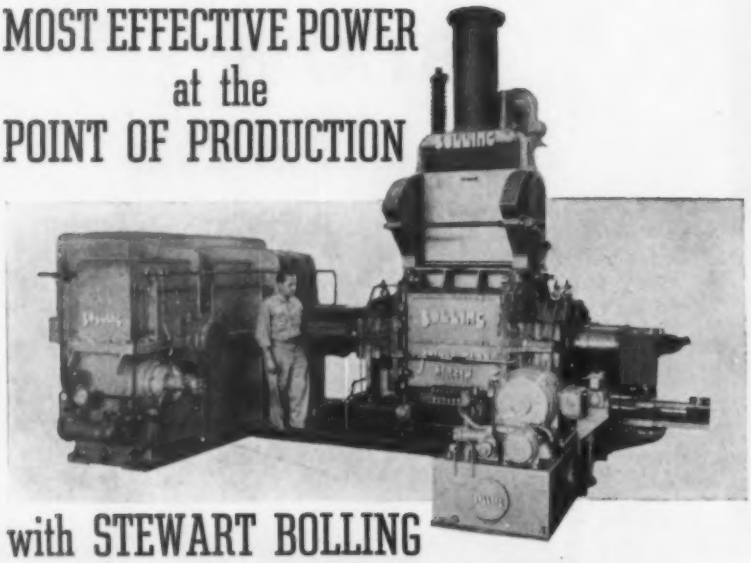

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Cellulosics

(From pp. 102-104)

to increase and cellulosics will be affected proportionately.

2. Automotive. Here, reduced car production had an adverse effect on cellulosics sales. The material has not lost many applications in that industry (steering wheels, knobs, armrests, interior trim parts —mostly propionate and butyrate), but reduced car production has naturally cut into plastics sales. No new applications in these areas are foreseen; however, no losses are anticipated either.

3. The general economy. In the past years, cellulosics frequently made up for lost applications by increasing poundage use in those areas where they were firmly established. Because of the general lowered level of economic activity, this balancing act didn't quite come off in 1960; the slack produced by the telephone switch to ABS and reduced car output was not taken up by any particular rise in other applications.

Ladies' shoe heels remain a tempting market. While the cellulosics may have suffered a temporary setback, they have by no means given up this field. As long as spike heels are in vogue, Implex impact acrylic will get the lion's share of the business. But cellulosics will move in strong again once heels become squatter—a trend that is now expected in the fashion world. Total market for this application is around 4 million pounds.

Toys still represent a fair market. Where clarity is required, cellulosics are the materials used. Roughly 5 million lb. went into this market last year. Pipe seems to have stabilized at the 3-million-lb. level, and is expected to more or less remain there.

THE GREAT HOPE of the cellulosic segment of the plastics industry is blow molding. Several blown acetate applications are currently under evaluation and are expected to be commercial within the next 18 months.

No one is talking as yet; but both packaging and industrial uses are involved. Some marketing savants feel that this development, if successful, may even result in a growing cellulosics market.—*End*

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Vinyl chloride

(*From pp. 91-97*)

(even before that, Johns-Manville had made vinyl flooring for the buildings of the Chicago World's Fair in 1932). Its vinyl asbestos tile business has increased nine times since 1950. The company also produces solid vinyl tile.

The solid and homogenous type vinyl floor coverings are estimated to have used over 45 million lb. of vinyl resin in 1960, despite the fact that this branch of the industry was probably more affected by the housing decline than any other.

The calendered-laminated section of the industry, which produces a vinyl-felt base material, is thought to have consumed about 20 million lb. of resin in 1960.

As noted above there is still lots of room for growth in the vinyl floor covering market. The leveling off in 1960 is generally deemed as only a temporary slowing-down due to set-backs in nearly all kinds of business. A total of at least 250 million lb. should be attained in the next five years.

If the estimates by various producers are anywhere near accurate, the sale of molding and extrusion grades fell some 20 million lb. in 1960 below the high figure of 1959. The separation into various end uses shown in the table on page 97 can be taken only as a guess, useful in indicating trends. There are so many variables in the way products are grouped in this classification that no two estimates agree.

However, the Tariff Commission's total for the entire batch is generally recognized by industry as reasonably accurate. Vinyl producers generally know how much of their resin production is used for extrusion and molding and can make an accurate report to the government; but an attempt to divide it up into various end uses involves a lot of guesswork.

The first difference of opinion among producers as to end-use markets is in the field of phonograph records. Early estimates for 1960 indicated a slight rise over 1959; later returns showed a decline. The large record producers did more business than in 1959, while the smaller producers generally showed a decline. Increased production of stereo records helped overall volume somewhat, but records of this type account for less than 20% of the recording business; Hi-Fi platters and L. P.'s are still the bulk of the business. There is a trend toward small records made of calendered rigid vinyl, but so far they have offered little competition to standard sizes.

THE SLUSH AND ELASTOMERIC molding classification is one of the most uncertain areas in the vinyl chloride category. There is little publicity about elastomeric moldings, although there are various molders who specialize in it and are doing very well. Included in such production are many industrial parts that are scarcely ever mentioned: wiring devices (especially for cords on electrical appliances) and a great variety of handles for tools, lawn mowers, and other wheeled equipment. The last two years have also seen an advance into the shoe business with heels for women's flats and with straight vinyl soles and heels for

various types of shoes. Earlier resins failed in this application because of cracking, but a new spongy type material that resembles rubber has largely overcome this problem.

Molded plastisol items are by far the largest portion of the 58-million-lb. figure shown in the table on page 97. There may have been some decline in plastisol-molded doll bodies, although several producers still use it for the so-called "baby-dolls"; nearly all doll manufacturers, however, stick to vinyl for heads because of its more lifelike appearance and texture. But if the use of plastisols for dolls has declined it has been more than made up for by the increasing volume of rain boots for women.

EXTRUDED PROFILES are another area in this classification where guesses by the trade are difficult to reconcile. Vinyl extrusions used in the building trades in 1960 were down, but use in the automobile field was up. One estimator thinks there is from 50 to 60 ft. of such extrusions in the average car: welting on upholstery, around windows, and for other purposes. This comes to 5 to 6 lb. per car.

Seven or eight million lb. is used for shoe welting each year and an additional large amount for semi-rigid extrusions as molding around ceilings. Then there are core bases and various extrusions used for electrical purposes. Women's belts consume a considerable amount of extrusions. Refrigerator gaskets is another big item. Vinyl monofilaments are still used occasionally for brushes and for automotive windlacing, where they are woven over sponge rubber. Clear vinyl tubing, for medical and chemical applications, for use in taverns as draught tubing, and for many similar uses, is big volume. Tiny-diameter tubing as for eye-glass templepieces, accounts for good volume.

An interesting development of a year ago—now growing nicely—is a magnetized extruded shape used in refrigerators, kitchen cabinets, women's purses, and other items where a closure between metal parts involves a tight fit.

And then, of course, there is the vast market for extruded strip in concrete water stops, highways, and window slides; these may be either rigid or elastomeric vinyl.

WIRE COATING is a "pride and joy" of the vinyl industry. It was one of the first applications and has grown fairly steadily ever since. Although it fell off a bit in 1960, because its largest use is house wiring, a 95-million-lb. volume is still big business. It is also used on wiring for pole-to-house telephone circuits. Here it is replacing neoprene; in other wiring applications it competes with polyethylene.

There will be some doubters who question the 25-million-lb. figure for rigid shapes and pipe, but the evidence is convincing. Pipe, conduits, and tubing is estimated to account for from 17 to 18 million lb., including, of course, rejects or waste. Those who estimate actual poundage of resin for pipe generally omit rigid tubing which is used in instrumentation and various other odd places, nor do they include conduits, which is rapidly becoming a large volume application. One company has now received Underwriters' approval for extruded vinyl

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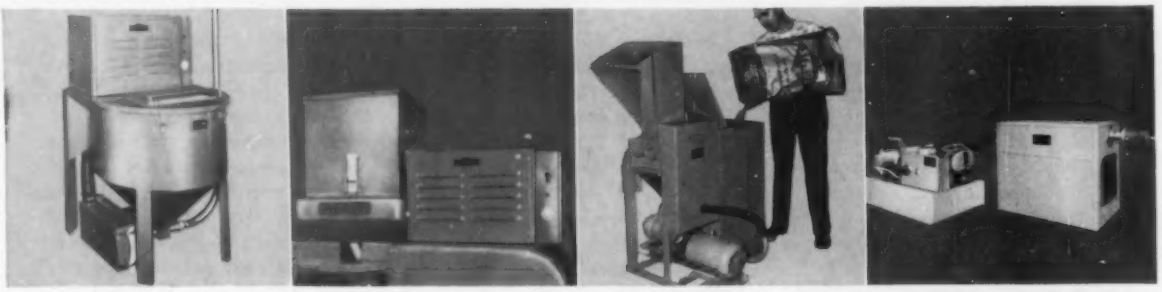

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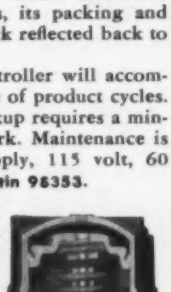

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conduit, which should give added impetus to demand for the material. There are several other conduit-producing companies who are doing well even without the U. L. approval by selling to customers who prefer it where resistance to corrosion or rust is needed.

The Japanese and Germans use much more rigid vinyl pipe than do Americans, but their material is mostly normal impact. In America, the use of impact rigid or unplasticized vinyl far exceeds that of normal impact.

Other extruded rigid shapes included in the 25 million lb. consumption figure are such items as stair railings, window frames and slides, and numerous industrial items. The stair railings, placed over steel, are easy to clean, have a comfortable feel, and don't have to be polished. Window frames have been under development for years—and at least three companies now have them on a commercial basis. There is a chance that vinyl window slides may become standard in most new construction.

The use of unplasticized (rigid) and elastomeric vinyl in extrusion and molding is likely to develop into a 50- to 100-million-lb. market in the next six or seven years. Articles in MODERN PLASTICS (Oct. and Dec. 1960) pointed out some of the fast-growing current applications and some of the future possibilities in the construction industry. While hundreds of thousands of words have been written about plastics in construction, most of this has been theory. However, the vinyl branch of the industry has made the most practical advances in actually providing construction materials and methods with which to go to work. Many of the largest building supply concerns are already deeply involved in the vinyl business, but developments are so comparatively recent that each is reluctant to release information in the hope that he can steal a march on his competitors. At the moment they seem most concerned with combining vinyl with other materials for structural panels. Wood, metal, asphalt, Celotex, and gypsum board are all involved. The hopes of the vinyl industry for using up its surplus capacity, and mayhap adding more, are tied in with a belief that this great con-

struction potential will become an actuality.

THE USE OF RIGID VINYL for structural parts, especially pipe, has in some respects progressed farther in Europe and Japan than in America. But domestic processors refuse to admit that the extrusion technique is less advanced here than in foreign countries. They think there are many other factors involved which account for overseas progress, such as unavailability of other materials in those countries, and in this country, higher costs, marketing problems, and building codes that slow down progress.

However, European equipment is being imported in significant quantity. This situation is about to be countered and remedied by lower-cost U. S. machines of similar design now being developed. In addition to their excellent performance on PVC materials, the screw preplasticating machines do a better job on all thermoplastics. This is because they deliver a more uniform, thoroughly heated and plasticated melt to the mold, which results in higher quality parts having less molded-in internal stress.

Another boost for increased use of unplasticized PVC is the pending introduction of the new Goodrich hi-temp vinyl dichloride resin which is scheduled to come into commercial production in mid-1961. This could be an epoch-making development in the history of vinyl chloride, since it is said to resist temperatures 60° F. higher than any previous vinyl chloride type resins. Extensive testing indicates that it will withstand 210° F. in service at normal pressures. It will thus be serviceable for carrying hot water in homes or buildings. No imagination is required to realize the potential market when such pipe is adopted by the building industry.

Vinyl plastisol or dispersion resins continue to be one of the more attractive formulations in the industry. They are found in one form or another in every classification named in the vinyl table on p. 96. Production in 1960 is estimated at around 100 million pounds. Plastisol formulators insist that this figure is too high. However, various analysts claim that the formulators either underestimate their competition or don't realize how much for-

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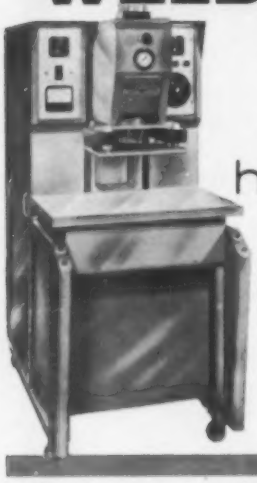

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mulating is done by the actual user of the plastisol—spread coaters, doll and toy manufacturers, etc.

Plastisol consumption figures are sometimes hidden away in unlikely places or in small quantity applications which, when added together, make big totals. One man makes fish worms from 50-gallon drum orders; a spread coater uses 300 to 400 thousand lb. of resin a month. More than 5 million lb. of resin is believed consumed in casting film, extruding profiles, insulating wire, and as covers for injection-molded items such as arm rests. Dip-coated wire baskets, gadgets for machines, nuts and bolts, take a good quantity of plastisol. Artificial flowers are a big market. Several million lb. a year is used around sewer pipe joints. One processor keeps a casting machine going almost the year round on medical tape. Several companies are extruding plastisol on fibrous glass yarn for screen cloth. Hobby horses and numerous toys are molded. A 10-mil coating is applied to aluminum house siding. The vinyl coating job on steel is still small—maybe a million lb., but when the expected big orders come along, this market could rise to 15 or 20 million lb. a year.

Spread-coating plastisols, although only 20 million lb. or so in 1960 because of a drop in upholstery applications, are picking up new markets. They are now used on burlap or paper for auto trunk liners and kick pads, on scrim for wall covering, and on fabric for tarpaulins. The above-mentioned coated paper component for floor coverings alone takes over 20 million lb. a year. And just last year plastisol moved into the booming market for outerwear jackets.

TARIFF COMMISSION FIGURES show that the calendering business enjoyed quite a boom in poundage volume last year. Despite this the calender operators claim there was little profit. Film prices were raised at the beginning of the year for the first time since the early 1950's, but according to some producers, there was considerable "chiseling" on list prices before the year ended. Neither will some film and sheet producers believe the government figures—they think some resin which isn't actually used for calendering purposes is getting into these figures. Yet despite such complaints, it seemed obvious that practically every calendering company enjoyed good business. Optimism in the industry was indicated by two new calenders put in operation in 1960; another is scheduled for 1961. Each calender line represents an investment of $500,000 to $1,000,000.

The film and sheeting business is so closely interwoven that separating the amount of resin used by each is difficult. It is best to combine them and, thus, compare the total of a little over 200 million lb. with about 185 to 190 million lb. used in 1959. Included in this figure is between 6 and 10 million lb. of extruded and cast film and 18 to 20 million lb. of calendered rigid or unplasticized sheeting.

The sheeting figure in MODERN PLASTICS varies from the Tariff Commission's figure, since the latter includes resin used for calender-coated fabric; we report this under fabric treatment. *(To page 185)*

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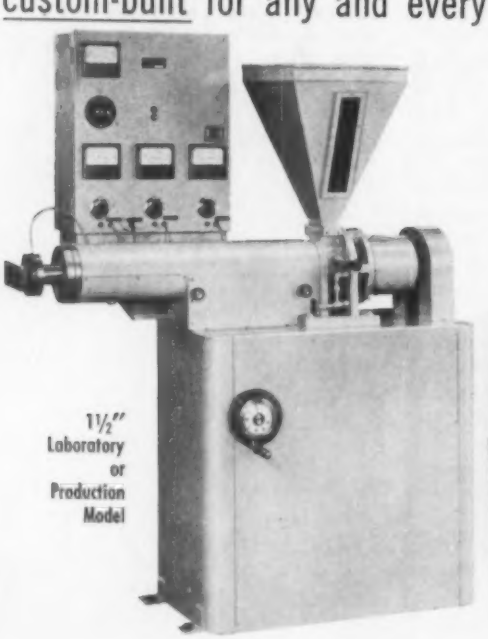

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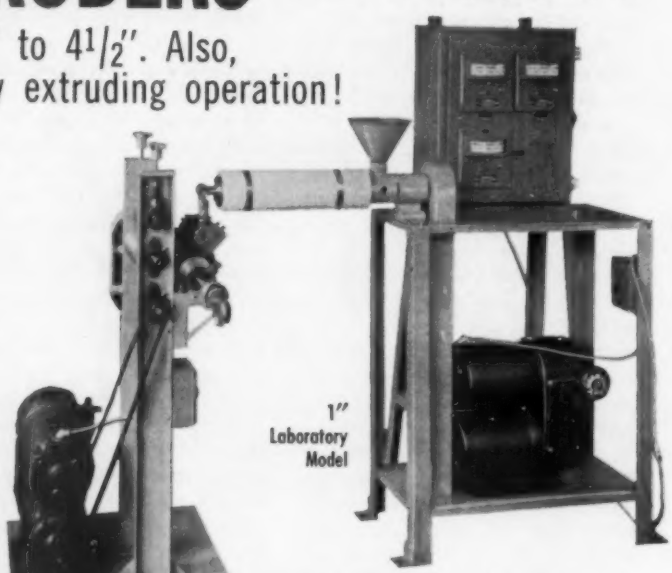

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The resin used in fabric treatment for 1960, and listed under this heading in the table on page 96, is estimated at from 41 to 45 million lb. for calender-coating, 20 to 25 million lb. for spread-coating, and a few million lb. for miscellaneous uses such as primer coating before the plastisol is laid down. Estimators' opinions on spread-coating resin used in 1960 vary all the way from less than 20 million lb. to as much as 34 or 35 million. The 12-million-lb. allotted to paper treatment by MODERN PLASTICS may be high; admittedly, some of it may belong under fabric treatment, and probably even some of the plastisol-coated paper used in floor covering is reported in this classification.

However, the resin volume reported for fabric treatment *does not* include the film and sheet laminated to fabric for the upholstery industry. Laminating use has grown to many millions of pounds, but is reported as resin used in film or sheeting.

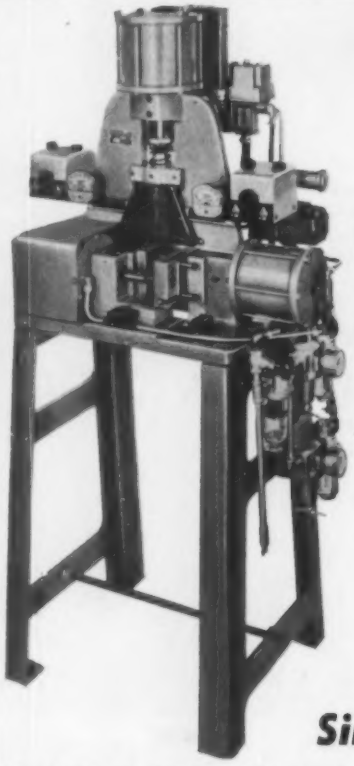
Increased use of vinyl sheeting in 1960 was due partly to the greater amount used per automobile, even though the "compact cars" have a smaller interior surface area. Other laminates and inflatable products also contributed generously to the upsurge.

The widely discussed vinyl-to-metal laminate probably didn't consume more than a million lb. of compound in 1960, but it is a most promising material for the future. Gradual rather than speedy growth of this application is anticipated. Such lamination is a specialized business that requires skill and experience; furthermore, the producer must have a large variety of patterns. The formulation is stiffer than most other film or sheet varieties and must withstand temperatures of 400° F. during embossing and adhering to metal.

A separation of vinyl chloride sheeting into various end uses is impractical, since there is general disagreement about what went where. But one producer was bold enough to guess that in 1959 his examination of the field indicated that about 60 million lb. went to upholstery; 20 million to inflatables and wading pools; 28 million to handbags, novelties, and shoes; 17 million to laminates; 10 million to book binding; 6 million to auto seat covers and convertible rear windows; 3.5 million to wall covering; and the balance to assorted uses. All these figures apply to sheeting of more than 10-mil thickness.

AN EXCITING DEVELOPMENT that took place in the third quarter of 1960 was the retail introduction of a new type of vinyl-insulated jacket for outerwear. This garment insulation can be made by casting a plastisol foam onto a fabric with a tough skin on the outer surface. However, the great part of this material was produced on calenders, using a conventional calendering resin into which is incorporated a blowing agent; after calendering, heat is applied to create an integral foam layer. The result is a soft, "sandwich-like" structure (vinyl skin, foam core) that has taken the sportswear market by storm.

The table on p. 95 that lists uses for vinyl film speaks for itself. The amount used for laminating and quilting is subject to more dispute than any of the other products;



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one reason is that both film and sheeting are used for laminates, with small chance of discovering which is which from a statistical viewpoint. There are scores of uses for vinyl film, including a vinyl skin over urethane foam for rug underlays, ironing boards, place mats; a film facing over padding for nursery items, head boards, head linings in autos; upholstery; wall coverings; handbags; novelties; table covers; flocked vinyl; skirts of auto seat covers; 3½-gage vinyl with nylon scrim for ground swimming pools and tarpaulins; beach umbrellas with printed vinyl top and bottom and a scrim interior core; outdoor chair webbing. The application accounting for the largest volume of vinyl film may be furniture, especially dinette sets which use a vinyl-to-vinyl unsupported laminate of 4 mils and over. Many calender operators have taken over this laminating business, since it is claimed that they can make film or sheet for laminating and then complete the operation faster than they can calender-coat.

Another area of growth is in adhesive-backed film. An interesting item here is an adhesive-backed vinyl with a metallized Mylar surface for appliance decorations, packaging, and boat panel decoration. The principal applications promising growth for adhesive-backed film, however, are wall coverings, wastebaskets, shelves, etc. At least five major companies now produce this film.

The original old-timer in this list of film applications has fallen on hard times. This would be curtains and draperies. Today there are only four or five large manufacturers of such items left, and even they also produce polyethylene drapes which are cheaper than vinyl.

The vinyl industry is big and vigorous—more versatile than any of its plastics kinfolk. Its volume will continue to grow for a long time to come, but the profit figure for the resin supplier and processor is nothing to brag about. There has been too much hurry to get into "something good." The result: a plague of over-capacity constantly hanging over the industry and resultant price instability. A period of adjustment that would allow demand to catch up with supply would be helpful.—*End*

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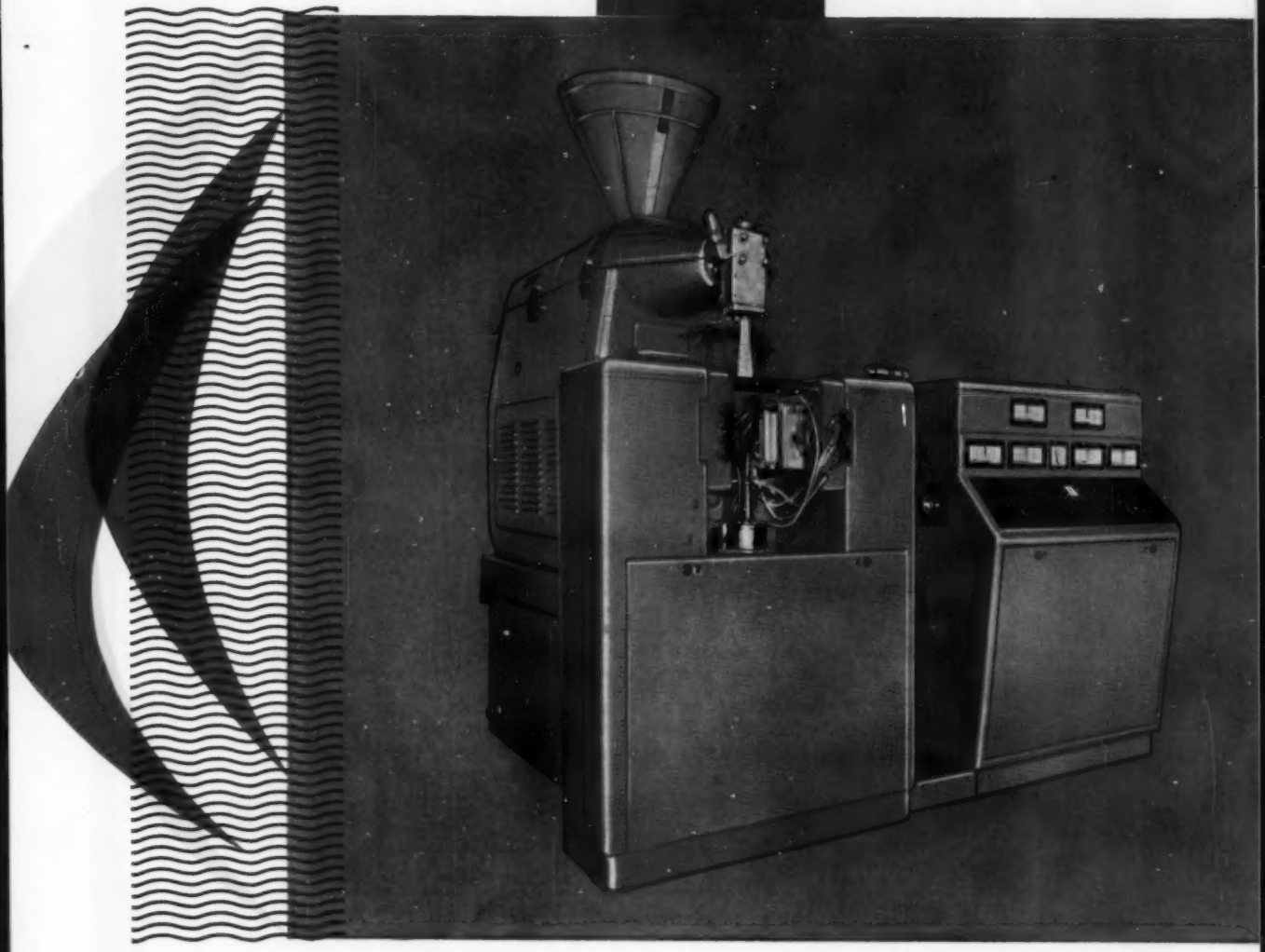

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Manufacturers' Literature

Described below . . . the latest literature, catalogs and brochures from the plastics industry. Dollar saving and dollar making ideas and data . . . available without charge.

EQUIPMENT • SUPPLIES • SERVICES

PLASTICS DESIGNING. 11-page illustrated brochure discusses basic rules and techniques for designing plastic parts. Covers such subjects es taper, wall thickness, threads, parting line, knurling, etc. American Insulator Corp. **(101-A)**

MOLD DESIGN, MOLD MAKING, MOLDING. 4-page illustrated brochure discusses the three most important phases of plastics production. Covers industrial, automotive and electronic industries. Byrd Plastics, Inc. **(102-A)**

PLASTICS PREHEATERS. 6-page illustrated folder describes high frequency equipment that offers greater economy in preheating plastics preforms. Complete information, specifications, operating notes, other data. Chemetron Corp., Girdler Process Equipment Div. **(103-A)**

BALING PRESSES. Illustrated brochure presents features of line of high-speed baling presses. Over 50 models for efficient baling of plastics, paper, light-gauge metals, etc., in bale weights ranging from 50 to over 1500 lbs. Consolidated Baling Machine Co. **(104-A)**

MOLDING PRESSES. 15-page illustrated brochure describes fiberglass molding presses featuring variable opening and closing speeds, variable stroke and opening and closing tonnages. Performance and construction features, other data. Erie Foundry Co., Hydraulic Press Div. **(105-A)**

FOAM MACHINES. Five catalog pages describe foam machines with capacities ranging from 150 grams to 50 lbs. a minute. Schematic diagrams, technical data, other information. Gabriel Williams Co., Inc. **(106-A)**

COLD MOLDING. 12-page illustrated catalog describes cold molding of heat-resisting compounds especially developed for electrical insulation—in sizes ranging from ⅛ in. diameter up to 24 in. square. Also covers hot molded thermo-setting plastics. Applications, specifications, other data. Garfield Mfg. Co. **(107-A)**

PLASTICS FOR INDUSTRY. Illustrated 12-page booklet features properties and typical end uses of various plastics. Detailed results of ASTM tests on styrene, polyethylene and vinyl chloride molding compounds. Information on forms, typical uses and characteristics of fabricating, extruding, calendering, and laminating materials, etc. Monsanto Chemical Co., Plastics Div. **(108-A)**

SPRAYING ORGANOSOLS. Illustrated catalog page describes line of organosols that can be sprayed with conventional equipment like ordinary enamels. For products of steel, aluminum, brass, magnesium, glass, etc. Physical characteristics, colors available, etc. The Stanley Chemical Co. **(109-A)**

PLASTICS DATA GUIDE. 12-page illustrated book summarizes the typical applications and advantages of many plastics—including polyethylene, epoxy, phenolic, polystyrene, vinyl resins and compounds, etc. Comparison charts included. Union Carbide Plastics Co., Div. of Union Carbide Corp. **(110-A)**

HEAT SEALING MACHINERY. 12-page illustrated catalog describes thermal impulse heat sealing machinery for thermoplastic materials. Includes hand, foot pedal, and power operated pneumatic and electromagnetic models. Vertrod Corp. **(111-A)**

SOLVENTS AND CHEMICALS. 4-page illustrated folder describes aliphatic and aromatic solvents. Includes test results on solvency, volatility, composition. Also discusses chemicals like paraxylene, durene, sulfonate, etc. Sinclair Petrochemicals, Inc. **(112-A)**

PLASTIC CYLINDERS. 6-page illustrated folder describes equipment for fabricating and beading plastic cylinders. Complete specifications, advantages, other data. Taber Instrument Corp., Sheet Plastics Equipment Div. **(113-A)**

TEMPERATURE CONTROL UNIT. Illustrated sheet describes new temperature control unit for plastic injection molding machines. Specifications, advantages, other data. Protective Closures Co., Mokon Div. **(114-A)**

VACUUM COATING. 28-page illustrated book discusses vacuum coating and describes vacuum coating equipment. Complete information, charts, other data. Consolidated Vacuum Corp. **(115-A)**

REACTIVE RESIN MIXES. Illustrated sheet describes equipment that proportions, dispenses and mixes reactive resin mixes. Features, specifications, other data. CPM Special Machinery Corp. **(116-A)**

PAINT STRIPPER. Instruction sheet covers paint stripper that successfully removes enamels and lacquers, epoxy finishes, vacuum-plated finishes, rubber coatings, melamines, plastisols, etc. Dytex Chemical Co. **(117-A)**

ALL PURPOSE GRANULATOR. 4-page illustrated folder describes granulator with improved bite and new 2-bladed rotor. Features new slicing action that cuts soft materials. Injection Molders Supply Co. **(118-A)**

SPECIALIZED RESINS. 56-page illustrated book describes line of specialized resins. Includes general information on plasticizers, stabilizers, colorants, fillers and lubricants. Also discusses pre-blending, mill-mixing, calendering, suggested basic formulations, etc. The General Tire & Rubber Co., Chemical Div. **(119-A)**

VINYL PLASTICS. 16-page illustrated book describes polyvinyl chloride resins. Includes information on plastics for wire and cable, rigid extrusions, flexible extrusions, molding, foam and sponge, plastisol molding, etc. B. F. Goodrich Chemical Co. **(120-A)**

SPARK EROSION MACHINE. 6-page illustrated booklet describes line of equipment that machines metals of all hardnesses by spark erosion. Complete specifications, principal dimensions, other data. Charmilles Engineering Works, Ltd. Inc. **(121-A)**

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POLYESTER RESINS. 12-page illustrated booklet offers comparative study of the corrosion resistance of a bisphenol polyester resin, a general purpose polyester resin, and an isophthalic polyester resin. Of interest to those in the chemical, paper, petroleum, metals, textile and other industrial fields. Charts, graphs, other data. Atlas Powder Co. (122-A)

REINFORCED PLASTICS. Folder with illustrated insert describes diversified line of reinforced plastic items—including telephone relay equipment cover, loudspeaker driver enclosure, trailer axle shield. Armored Plastics Co. (123-A)

SHEET CLEANER. 4-page illustrated folder describes sheet cleaner that assures fast, steady running . . . full production without stops for unnecessary wash-ups. General information, diagrams. The J. E. Doyle Company. (124-A)

STABILIZERS. 30-page book describes line of liquid and solid stabilizers. Covers such subjects as stabilization of polyvinyl chloride, stabilizer recommendations for specific applications, table of physical properties, and other information. Argus Chemical Corp. (125-A)

PORTABLE HARDNESS TESTER. Illustrated catalog page describes portable hardness tester for aluminum, aluminum alloys, copper, brass, other soft metals and plastics. Engineering data, schematic diagram, etc. Barber-Colman Co. (126-A)

BALL JOINTS. Comprehensive catalog covers wide variety of subjects including ball joints, struts and vibra-snubs, self-aligning swivels, plane swivel-swing joints, rotary joints. General information, specifications, diagrams, other data. Barco Mfg. Co. (127-A)

GRANULATORS. Literature describes line of material granulators—including wide throat and heavy duty granulators. Drum tumblers, plastic pelletizers, heater-dryer attachment also covered. General information, features, specifications. Ball and Jewell, Inc. (128-A)

PLASTIC-MOLDING STEEL. 4-page illustrated folder describes tool steel that's ideal for plastic molding because it takes high, mirror-like polish. General information, applications, other data. Bethlehem Steel Co. (129-A)

SUBSTRATES. 4-page illustrated folder covers line of eight transparent films used as bases or substrates for polyethylene extrusion coatings and laminations. Information includes characteristics of substrates, barrier properties, particular advantages of each substrate. Charts, graphs. E. I. du Pont de Nemours & Co., Inc. (130-A)

SHEETS, RODS, TUBES. 16-page properties chart covers thermoplastics, thermosets, high pressure laminates. Includes information on specific gravity, refractive index, compressive strength, specific heat, etc. Commercial Plastics & Supply Corp. (131-A)

WIRE GAUGE. 4-page illustrated folder describes wire gauge that offers non-contact measurement and automatic diameter control for thermoplastic and rubber insulated wire, extruded tubing, rods, shapes, filaments, special wires. General information, specifications. Daystrom, Inc., Weston Instruments Div. (132-A)

SPRAY GUNS. 16-page illustrated booklet describes line of hand spray guns, automatic spray guns, flow guns, lubricating and cleaning guns, air dusting guns and accessories. General information, advantages, specifications. The De Vilbiss Co. (133-A)

EXTRUSION COATING. Catalog pages describe new low-density resin for extrusion coating of paper and other substrates. Physical properties, other data. Eastman Chemical Products, Inc. (134-A)

AUTOMATIC MOLDING PRESSES. 8-page illustrated booklet and specification sheets describe line of self-contained automatic molding presses with capacities ranging from 60 tons to 450 tons. General information, diagrams, other data. Baker Brothers, Inc. (135-A)

EXTRUSION COATERS. 12-page illustrated booklet describes line of extrusion coaters built for speeds up to 1,500 FPM, with wide range of coating thicknesses down to a minimum of .0002 in. Covers extruder with die, laminating unit, unwind and winder, auxiliary equipment. Frank W. Egan & Co. (136-A)

REINFORCED PLASTICS. 4-page folder describes reinforced plastics that offer durability, structural strength, molded-in finishes, etc. Industrial applications, molding techniques, average values of typical pre-mix molding compounds included. Firmaline Products. (137-A)

ADHESIVES. 16-page illustrated folder describes adhesives that eliminate welding, riveting, stitching, nailing. Handy glossary of adhesives terminology. Also recommendations for specific bonding applications. The Firestone Tire & Rubber Co., Xylos Rubber Co. Div. (138-A)

INJECTION MOLDING. Illustrated sheet describes hydraulic injection molding machine with fingertip adjustment; no tie bar adjustment required. Important features, specifications. Fernholtz Machinery Co. (139-A)

POLYESTER RESINS. 10-page booklet covers polymerization of polyester resins with catalyst. Discusses general principles of catalyzation; includes catalyst concentration chart. Specifications, properties, handling and storage of catalysts. Ferro Corp. (140-A)

PLASTICS. 10-page illustrated book describes popular plastic material. Covers heat dissipation, resilience and compressibility, coolants, speeds and rates of feed, clearances, burrs and chips, etc. Full information, applications, other data. Raybestos-Manhattan, Inc. (141-A)

INJECTION PRESS. 4-page illustrated folder describes completely automatic pneumatic plastic injection press—with ½ oz. capacity. Advantages, specifications. Simplomatic Mfg. Co. (142-A)

DECORATIVE LAMINATES. Technical bulletins feature popular resin—prepolymer of diallyl phthalate—that produces moisture-proof, solvent-proof and abrasion-resistant plastic laminates. Food Machinery & Chemical Corp., Chemicals & Plastic Div. (143-A)

PLASTICS. 12-page illustrated book describes line of melamine, urea and alkyd molding compounds. Also covers nylon molding and extrusion compounds, polyethylene, urethanes, etc. General information, specifications, other data. Allied Chemical International. (144-A)

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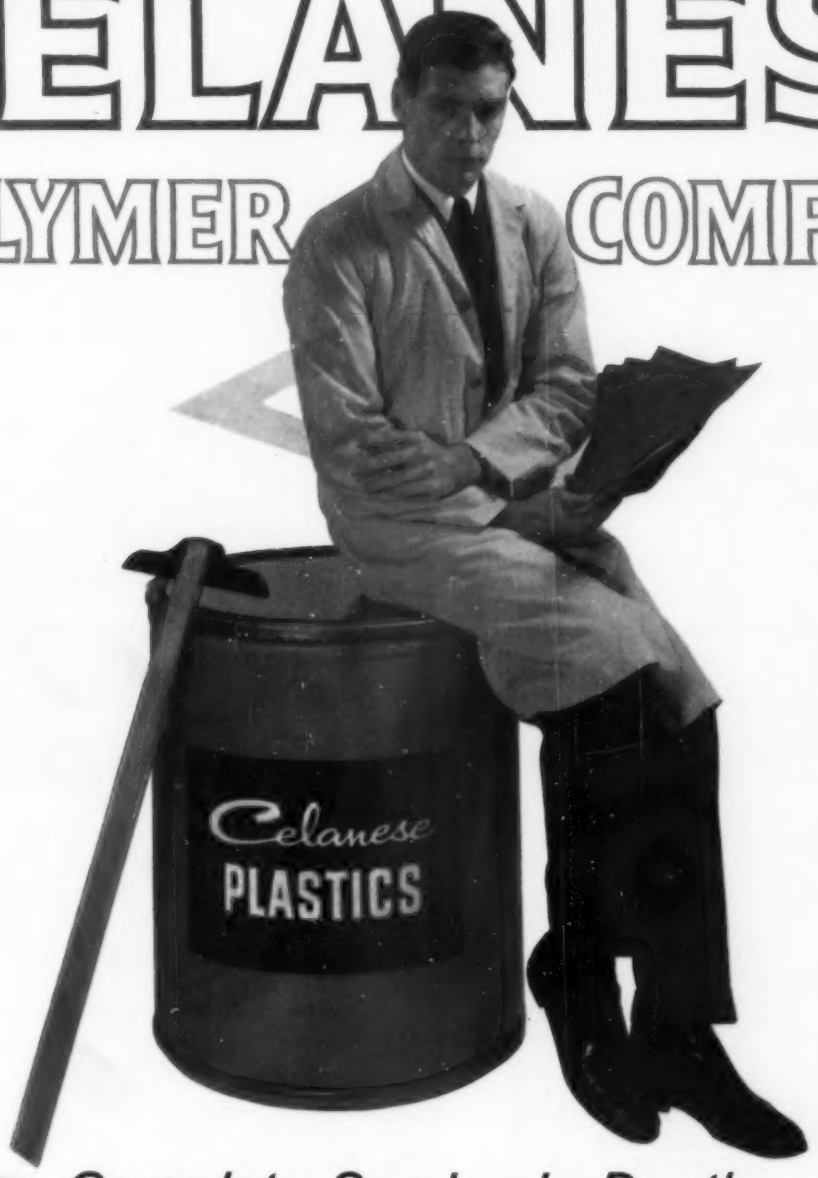

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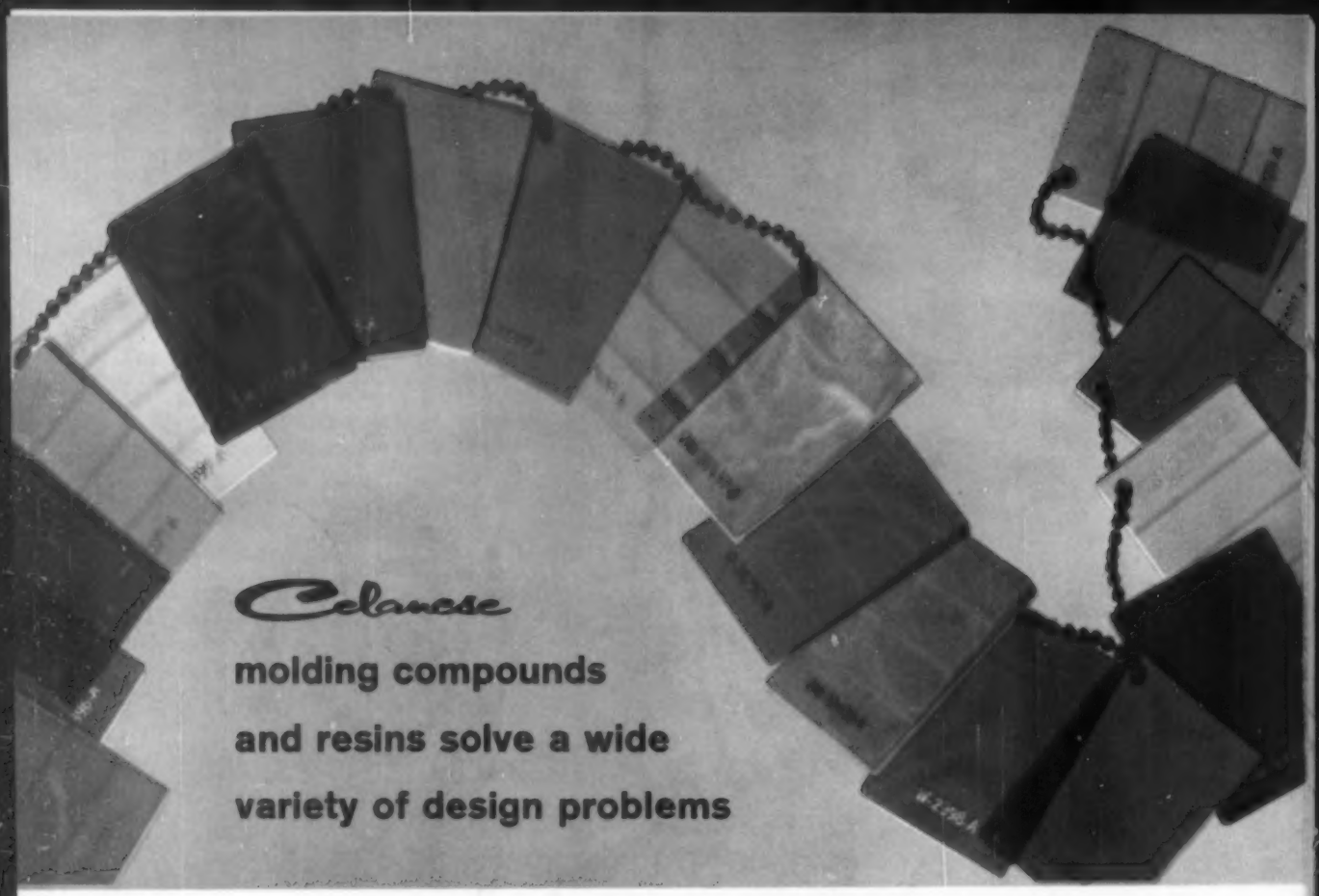

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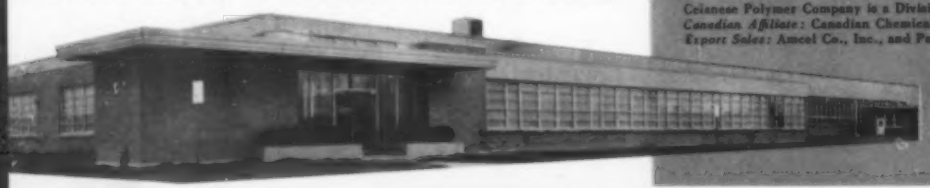


Celanese
PLASTICS

Polystyrene

(From pp. 97-102)

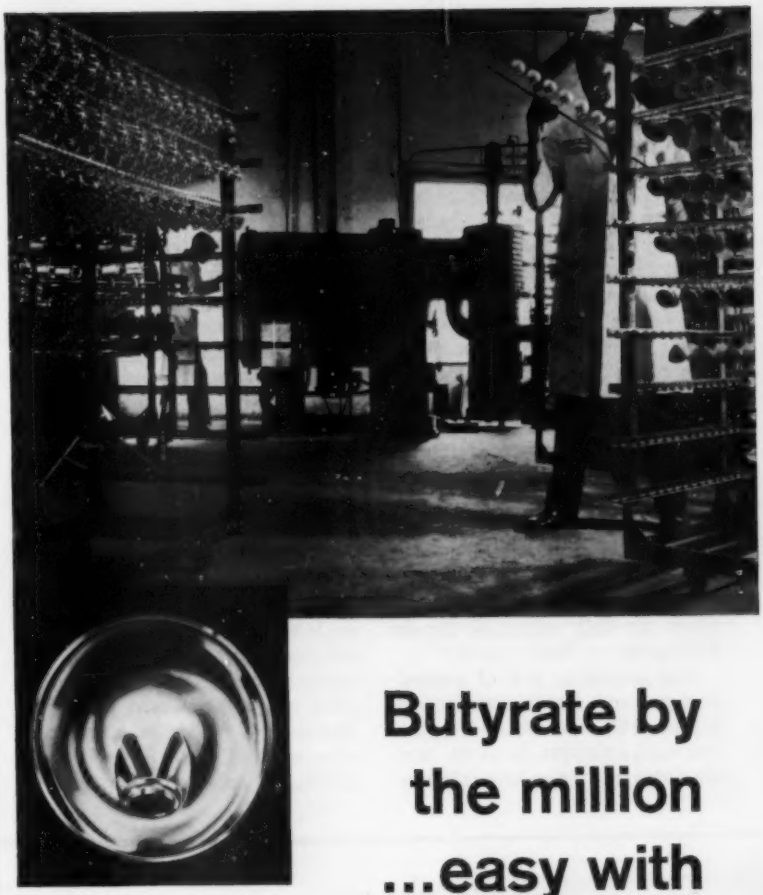
arm rests and kick panels, machine housings, women's shoe heels, luggage, appliances, dishwashers, sweeper parts, and a wide variety of other applications.

Considerable conjecture is passed around concerning the possibility of lower prices for acrylonitrile-type styrene copolymers, since the prices of both monomers that go into the copolymers have decreased considerably over the years. The ANS type of 70% styrene-30% acrylonitrile is based on a blend of a 12¢ material and a 24¢ material but the cost of production is high—acrylonitrile (vinyl cyanide) is dangerous to handle and the explosive reaction of the two is critical. A safety-proof plant is expensive to build and to operate.

Another styrene-type copolymer, Dow's Zerlon styrene-methacrylate combination, a material designed to compete with methacrylate polymers for use in sign, automotive, and refrigeration applications is still being tested, particularly for weathering. But it is expected to gain acceptance in several markets. It has a price advantage over methacrylate — 49¢/lb. compared with 55¢, and it weighs 14.2% less.

Two styrene-type products deserving of mention, though still in comparatively small volume, are foam and film. Consumption of all styrene foam is thought to be in a 40- to 50-million-lb. range and growing rapidly. Molded foam drinking cups made their debut about two years ago. Packaging use has multiplied at a furious pace, but is still small potatoes compared to use of foam as insulating material in new construction. Use in boats and rafts as a flotation material also shows activity. Monsanto has entered the styrene foam field with a variation—foam film or Santofome—that is expected to compete pricewise with paper for decorative purposes. Santofome is 10 to 30 mils thick. Cups can be made from this material on paper cup-forming machines. It has dozens of possible uses. Reports on styrene foam were given in the July, September, and October 1960 issues of MODERN PLASTICS.

Polystyrene film looks extremely promising and is now available in thicknesses from ¾ up to 20 mils;



Here's the millionth butyrate flashbulb reflector metallized by Luster-Coate Metallizing Corp. in a single CVC 48" coater.

Butyrate by the million ...easy with CVC coaters

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Consolidated Vacuum Corporation

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Plax Polyflex biaxially oriented film from 5 to 8 mils thick is now widely used for thermoformed lids and packages. Dow's Trycite, not yet more than 3 mils thick, as well as thin Polyflex and Visking's new Visolyte, are working into markets where low cost and dimensional stability, but not necessarily great strength, are involved. For window envelopes it is cheaper than acetate and may even compete with glassine in the future. Crispness and clarity are major properties of this film but it is also being upgraded to eliminate static, to reduce scratchability, to permit heat or solvent sealing, and to give better barrier properties.

Another stimulus to polystyrene film growth is the development of a cold-forming process by which die cut blanks can be formed into lightweight trays. The technique seems especially applicable for the folding carton field.

The percentage use of general-purpose and impact styrene for various end uses showed several interesting changes in 1960. Volume of use in household refrigerators went down 4 percentage points and represented a loss of 25 or 30 million pounds. This loss was partially made up by increases in packaging, housewares, and appliances.

There are many signs in evidence to indicate that the use of plastics in refrigerators is on the verge of either a revolution or a long step forward in evolution. The refrigeration industry is optimistic about its efforts to build a refrigerator with thinner walls and greater storage capacity. A great part of this optimism has been created by the potential use of urethane foam as the insulating medium. This development may take two years before it reaches maturity, but when it does become established, the use of styrene-type materials in refrigerator shells backed up by foam could grow to 130 to 150 million lb., according to some estimators.

If the volume of polystyrene has declined in refrigeration it has been made up for in packaging. This part of the industry grew from less than 50 million lb. a few years ago to well over 80 million in 1959, and ended up somewhere between 90 and 98 million lb. in 1960. Estimators differ since they don't all agree on what products should be classified as packaging. The figure used by MODERN PLASTICS includes general-purpose, impact, and off-grade resin, film, and foam cushioning such as that used for typewriter shipping boxes.

Polystyrene is giving promise of becoming the "pig iron" of the packaging industry—not because it has properties like iron but because it can be used to fit so many packaging needs at very low cost.

Bottles and jars are an example. Almost no polystyrene bottles and jars are produced today but the packagers are missing a bet if they don't examine its possibilities. Impact styrenes can be injection molded, thermoformed, or blow molded into thin-wall or thick-wall bottles or carriers of variegated size or shape. There have been some unsuccessful efforts in general-purpose for bottles, but improved impact styrenes are different. A blow molded impact styrene container for talcum powder is already on the market. In

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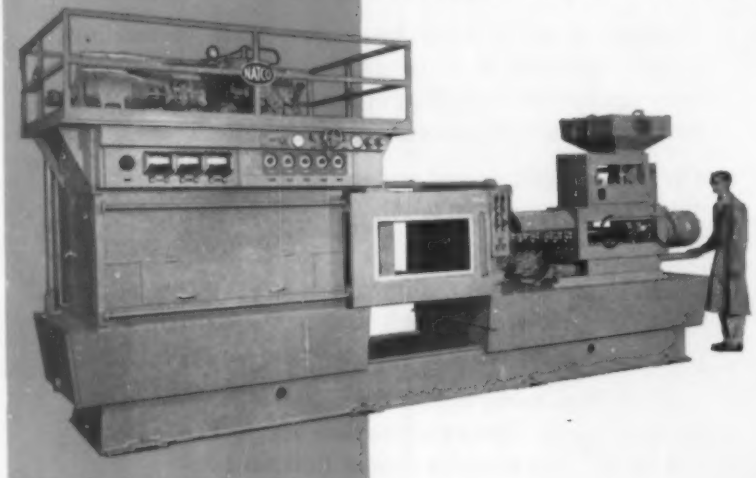

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Europe, injection molded bottles are used for vinegar. Styrene foam also has prospects for packaging and is already being used for cosmetic jars. Styrene foam film is similarly showing potential in spiral-wound containers and insulating bags. A sizable portion of general-purpose polystyrene is now even being used in 60-mil-thick molded jars for Mentholatum with so much success that producers of other "ointments" are interested.

Two styrene copolymer blends, methacrylate and acrylonitrile types, are particularly interesting as food packaging prospects. They have extra-fine clarity and a record for chemical resistance.

Right in line with bottles as markets for prospective volume use are closures. At least 10 million lb. is now used for this application. Impact grade is considered best for closures, but caution in compounding is advised to ensure good performance. Too much rubber in the formulation may cause overrun in the closure and too little reduces aging properties under loading and also raises costs. A liquor company now switching to a bottle closure of impact polystyrene from one of phenolic is said to have experienced less breakage with the new type. Estimators predict that use of styrene-type closures will eventually consume more poundage than today's entire thermosetting closure market.

Table-ready decorative containers, in which the eatable product can be served, are already in use, but the quantity use here is tiny compared with what may be expected. Cottage cheese alone could use 750 million one-pint containers. For impact sheet at 15½ gm. this could be large volume. Thermoformed cups that can be used for containers or sold for hot and cold drinks are claimed to be competitive with paper. Greater strength to weight and more heat resistance are favorable factors.

The biggest current application for polystyrene in packaging is, of course, containers and lids. To show the volume of various types of polystyrene packaging applications, one producer has made the following estimate of the most widely used varieties in 1960, in terms of millions of pounds of styrene used:

Ice cream containers	9
Cottage cheese containers	4
Hot drink cups	1
Tomato boats	8
Stock boxes	20
Closures	10

The next-fastest growing application in polystyrene for 1960 was appliance housings. This area includes housings for television, radio, and scores of other items, especially such small household units as electric knife sharpeners or can opener gadgets. Most of this material is high impact grade which has been made more serviceable by introduction of better heat resistant formulations. These formulations are also now applicable in automotive use or duct work, air intakes, and the like. And, as a matter of course, their use applies to lighting fixtures. This latter market used 7 or 8 million lb. a few years ago and now consumes something over 12 million as a result of continual improvement in polystyrene's light stability.—*End*

The MOLDER'S Molding Machine . . . The New NATCO 400 gives you . . .

28 oz. SHOT—single feed!

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Shot Capacity	28 oz.
Clamp Pressure (Max.)	425 or 550 Tons
Platen Size	38" x 38" or 38" x 41"
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Plasticizing Capacity	165 lbs. per hr.
Stroke (Max.)	28"
Horsepower	47½ or 87½

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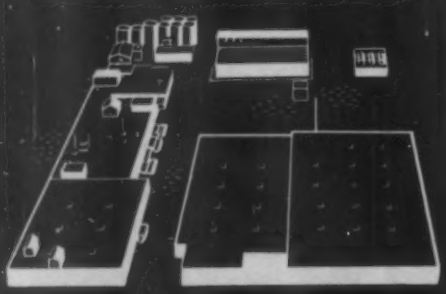
VINYL RESINS



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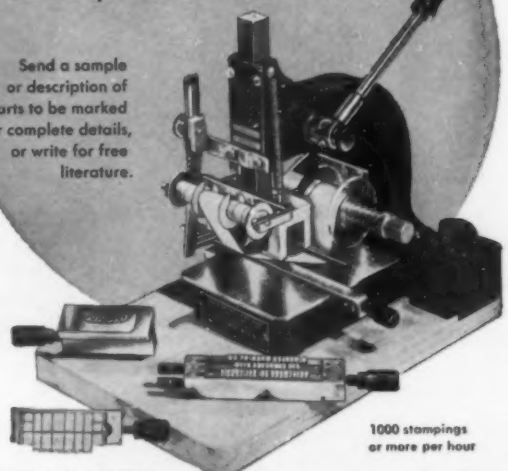

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Methacrylate

(From pp. 104-105)

ing fixtures continued to grow.

Use of regular molding material for extrusion is a comparatively small part of total sales, although it has been used consistently over the years for diffusers on lighting fixtures, flat or corrugated sheet. Methacrylate molding material volume for 1960 was little less than 1959. The declines mentioned above were small but were enough to prevent the industry from showing higher sales.

Attempts at producing extruded sheet from methacrylate beads, which are available at a cost lower than that of regular molding grade, have not yet become popular.

CAST METHACRYLATE SHEET is said to increase in volume each year. Estimators use a figure of from 50 to 60 million lb. in each of the last two years. The most important items made from sheet are signs, glazing, sky lights, and building components such as louvres, decorative facades, and panels.

There were no price changes in sheet during 1960, but there had been a fairly steady decline since 1954. A general average today would be 30 to 40% under the price of six years ago. As an example, the ¼-in. sheet which was $1.50/sq. ft. in 1954 is now about $1.00 a sq. foot. The ⅛-in. sheet is down by an even greater percentage. The above does not refer to the so-called military types, used where optical clarity is critical and tolerances are close. Price of this grade has not declined.

IMPACT METHACRYLATE RESIN, the Rohm & Haas Implex, was reduced in price last March, to 46½¢/lb. from 56 cents. It is now competing actively with the acrylonitrile-butadiene-styrene copolymers. It has captured a large portion of the market for spike heels for women's shoes, is moving into the business machine market as keys for typewriters, adding machines, etc.; is also useful for piano and organ keys. Automotive uses include armrests and bezels. Toy makers are beginning to use it.

DU PONT'S LUCITE acrylic sirup is beginning to gain ground as a replacement for polyester resin in fibrous glass reinforced plastics. Its advantages over polyester are claimed to be weatherability, initial superior appearance, and increased light diffusion—all of which are important in outdoor applications such as panels, glazing, and awnings. It costs about 5¢/lb. more than the better polyesters. It requires a careful processing technique, but should cost no more to handle after know-how has been acquired and process control established. It is easy to believe that this material is certain to acquire a large part of the reinforced plastics market in those areas where outdoor weatherability is needed.

A new producer of methacrylate molding material who began pilot plant production in January 1961 is J. T. Baker Chemical Co., Phillipsburg, N. J. Their material, previously called PL-11 and now named Bavick-11, is a copolymer of methyl methacrylate and alpha-methyl styrene. It is said to have high heat resistance even under moderate stress. Tests indicate that it retains a good share of its room-temperature strength at temperatures over 200° F. In contrast, crystalline polymers often deform when loaded at elevated temperatures. It is resistant to many chemicals, including hot caustic. It molds easily but is highly viscous and cannot be molded with pin point gates.

This material has been available for less than six months from Baker's small semi-commercial works, but is already said to be giving satisfactory use in instruments such as pointers on military aircraft, where heat from back lights would break the glass previously used here. For commercial uses it may be applicable for knobs, buttons, and dials on electric ranges, for drug sundries, such as nasal sprays that require sterilization, for autos where light bulbs set close to the lens give off too much heat for glass.

It is expected to compete generally with glass in spots where heat has been a detriment. Development price will be $1.50/lb. but, as usual, price is expected to decline when sales reach moderate volume.

Escambia Chemical Corp. is another company that may be heard from more definitely in relation to development of methacrylate in 1961, since its development program is almost complete.—*End*

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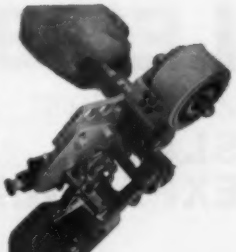

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Nylon

(*From pp. 105-106*)

ages about 8 oz. per car. Some applications have met competition from polypropylene, but it is still too early to know how various other plastics will fare in their efforts to move in on nylon in the automotive market. Wire coated with nylon is a leading application in automobiles as well as in airplanes, but gears, bushings, lockset parts, etc., are still predominant.

Washing machine valves that made such a big hit several years ago, because of chemical resistance and moldability in complex forms, were another item threatened by polypropylene, but the latter has not yet proved that it can take over. The reader may note here that polypropylene producers are working hard to move in on various nylon products, stressing polypropylene's heat resistance, chemical resistance, and lower cost as noted in the above discussion on price reduction.

THERE HAVE BEEN SOME disappointments in trying to develop nylon consumer products. Roller skates, for example, cost more than the older conventional type. But, on the other hand, a new egg beater with nylon parts, including the blades, will sell for $2.50, compared with the older model at $3.95. Combs and tumblers are probably the best examples of successful consumer items for which customers are willing to pay a premium price. Another good item in the consumer class is the Remington .22-caliber rifle stock, which has been so satisfactory that the company may adopt the idea to other calibers. Another growing consumer item is sunglass frames. Eyeglass frames are a possibility, but still need development work to overcome swelling characteristics that would permit the glass to drop out during use.

Overall there were about 350 new nylon applications developed in 1960—should be about the same in 1961. This is far more than enough to overcome the fatalities that occur each year, but, unfortunately, most of the new items are so small that poundage used is limited. Small molded bottles are an example. A guess on the largest molded nylon item in this country would be the 24-oz. stock on the Remington rifle. In Europe such things as automotive fan blades and ship propellers molded from nylon are fairly common.

EXAMPLES OF LARGER ITEMS that are coming along in the U. S. are a casing on a ¼-in. drill, now widely used in Europe where electrical codes are more strict, and an extruded biaxially oriented nylon 6 sheet to serve as the core for heavy duty conveyor belting that will handle rock, coal, and other heavy materials.

Competition for nylon bristles—used in all kinds of brushes from tooth to street sweeper—is developing from polypropylene, but nylon bristle use continues to increase from year to year. Du Pont says of its nylon (Tynex) bristle that "filaments are available in tapered or level form, crimped or uncrimped, and in diameters so thin it can be used to make the softest of complexion brushes and so thick it can be used in mechanical street-

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Producers of both nylon 6 and 6/6 are continuing their efforts to put more nylon into the extrusion field. The nylon 6 producers have always claimed that their material is especially suitable for that purpose. Du Pont, producer of 6/6, has had a special formulation, Zytel 42, for extrusion for several years but has recently developed a new composition with what they believe is a more perfect viscosity for extrusion purposes. One problem heretofore has been the rapid change from solid to liquid—almost like ice changing to water. The new composition changes more slowly—gives the extruder operator a better opportunity to control his production.

Any discussion of extruded nylon always brings up the possibility of film. Such film has been around in experimental lots for many years, but a market has never been developed. Cost has been a factor, since up to now at least it would have been priced at from $2 to $3 a pound. Furthermore, it picks up moisture during processing and results in a crinkly roll with poor appearance. But the problems of processing could undoubtedly be overcome if a market of sufficient size were found.

AMONG THE ADVANTAGES of nylon film are clarity and high strength without orientation. A nylon film would make a good packaging material for heavy items like hardware. It is strong and clear—can be heat sealed. Oriented polypropylene also has clarity and strength but can't be heat sealed without a coating. It would be excellent as a visible package for gears that could be shipped without cosmoline. It might be used for a boilable pouch for frozen foods or for skin packaging with a polyethylene coating for sealing against the display board.

Speculation on the future for nylon film comes up every year—one year it's thumbs down, the next year it looks promising. If research continues it may yet become a potent product. "It sure is beautiful stuff" says almost every person who is privileged to see one of the better samples.—*End*

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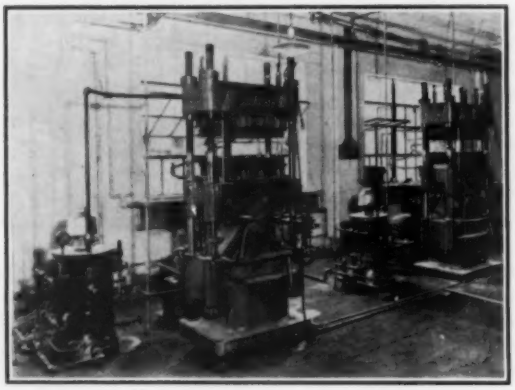

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Delrin

(From page 106)

1.14, compared with 1.425 for Delrin.

Probably the best way to indicate how this material is getting along in its first year of commercial production is to list some current Delrin applications, as follows:

Thirty-eight parts in automobiles. Leading the auto parade is an instrument housing on the Valiant. Dimensional stability and light weight helped win the job. Also in the auto field, Delrin won a design award for the Walker Lubricator, where it forms the housing and some of the pump mechanisms. The lubricator drops oil automatically into lubricating systems.

Instrument panel lamp sockets for baseless bulb on panel lamps.

Air hose coupling for trailer trucks.

Remote control interior door handle and window cranks in trucks.

Corrosion-resistant engine drain plugs. Replaced cast iron.

Pump parts. It is cheaper than brass. Is stiff and light weight. Will take heat if water flow stops and pump gets hot. Susceptibility to moisture is very low.

Conveyor belt links and wear strips.

Aerosol bottle for cologne.

Commercial dishwasher fingers which were formerly stainless steel that scratched chinaware.

Corn planter parts. Delrin distributor plates for seed are wear resistant, light weight, abrasion resistant. Replaced iron. Another planter part is a chain drive sprocket that requires no lubrication.

Cooling fan blades for electric motors.

Lawn furniture nuts that are self-locking, self-threading, corrosion resistant, won't rust or drop off.

An in-line fuel filter (one-half Delrin and one-half nylon) used for gasoline engines on lawn mowers. Can be bought in any hardware store and put on a gas line almost anywhere.

Fishing reel housing and parts that can be bought for $1.00 and wired to any bamboo fishing pole.

Lady Ronson electric shaver head and parts. Replaced zinc die casting. Provides light weight, prevents oscillation.

Model airplane racing propellers.

Car couplers for Lionel model train sets.

Hand can opener bushings—don't corrode from citrus juices as do metal types.

Pencil sharpener parts.

A shock absorber housing for water lines in homes.

Kitchen garbage disposal tops.

Oil field piping systems. Delrin is light, weighing about ½ lb./ft. for 2-in. pipe with a 100-mil wall thickness. Strong in the presence of oil, even at temperatures of 250° F. with 150 to 200 p.s.i. and 15 to 30 min. exposure. Tough, solvent resistant, and resists the effects of underground burial and outdoor weathering. Can be joined by melting outer surface of pipe and inner surface of a sleeve-type coupling, which is included on one end of pipe. Bonded by hand pressure with joint stronger than pipe itself. Can also be joined to metal pipe by using a molded Delrin flange.—*End*

Polycarbonates

(From page 107)

This will bring it into the range of several other premium-priced engineering-type plastics.

Rumors were flying thick early in the year as to who was going to be in this picture. But, when the situation had cleared, only two companies emerged as domestic producers of polycarbonate resins: General Electric Co. and Mobay Chemical. Neither firm has ever revealed capacity figures, but talk in the trade places it at a combined total of 12 to 15 million pounds.

SALES OF POLYCARBONATES are currently running at a rate of about ½ million lb. per year. By the end of 1961, sales are expected to reach the 1.5-million-lb. mark; and an increase to between 30 and 50 million lb. by 1965 is forecast. Estimates for the year 1970 visualize sales of 100 million pounds.

Typical products where polycarbonates are currently being used include telephone connector parts, relay bases, coil forms, pump impellers, computer parts, and various kinds of electrical components where critical design problems exist in terms of dimensional stability, heat resistance, impact strength, and electrical properties. Altogether there are more than 300 commercial applications, with much experimental work in progress.

In addition to these markets, General Electric reports that considerable experimentation is being done with various techniques of applying decorative and protective surfaces. These include vacuum metallizing and flame coating of metals. Other efforts involve the use of fillers to achieve special effects, including higher strength, improved flame retardance, ultraviolet ray resistance, etc. While some of these developments have shown considerable promise, none has reached the commercial stage.

At this point, according to Mobay, indications are that polycarbonates are off to a very strong start in terms of technical service knowledge, development of commercial applications in a wide range of industrial fields, and a high level of sustained interest among the astute materials specifiers of the custom molding section of the industry.—*End*

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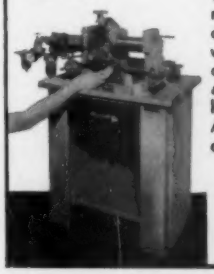

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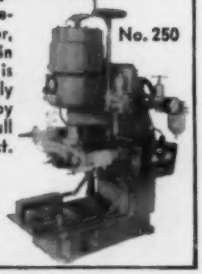

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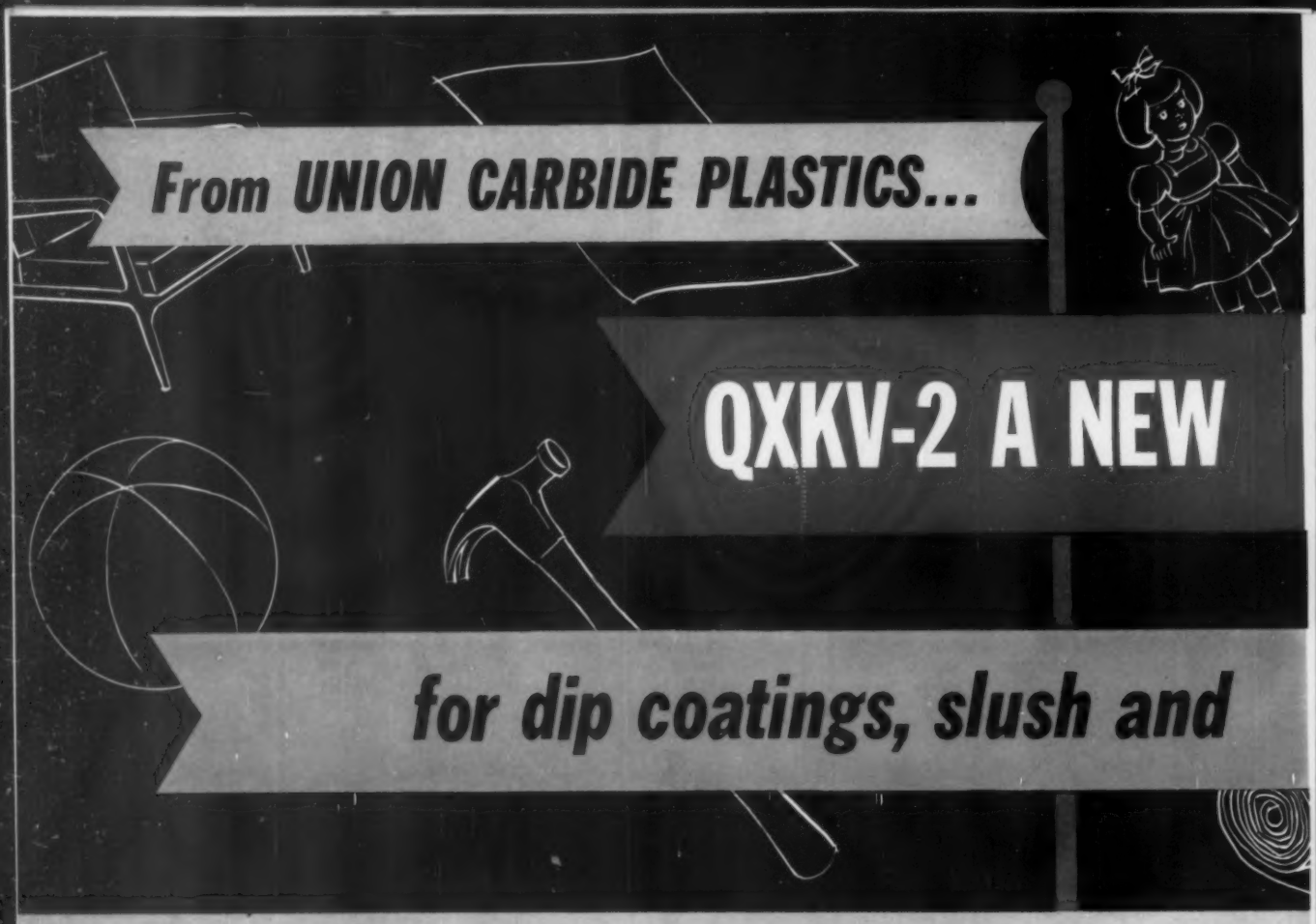

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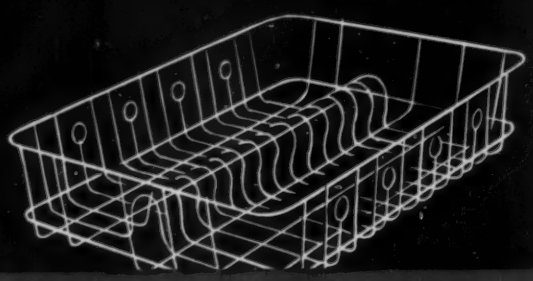

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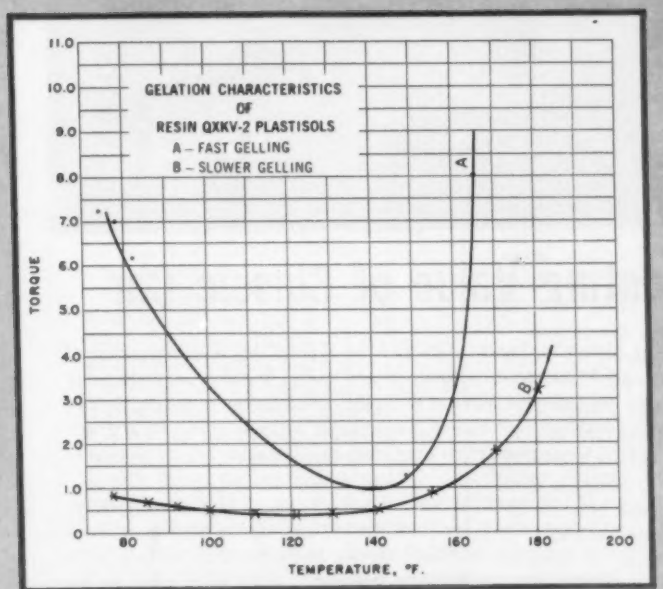

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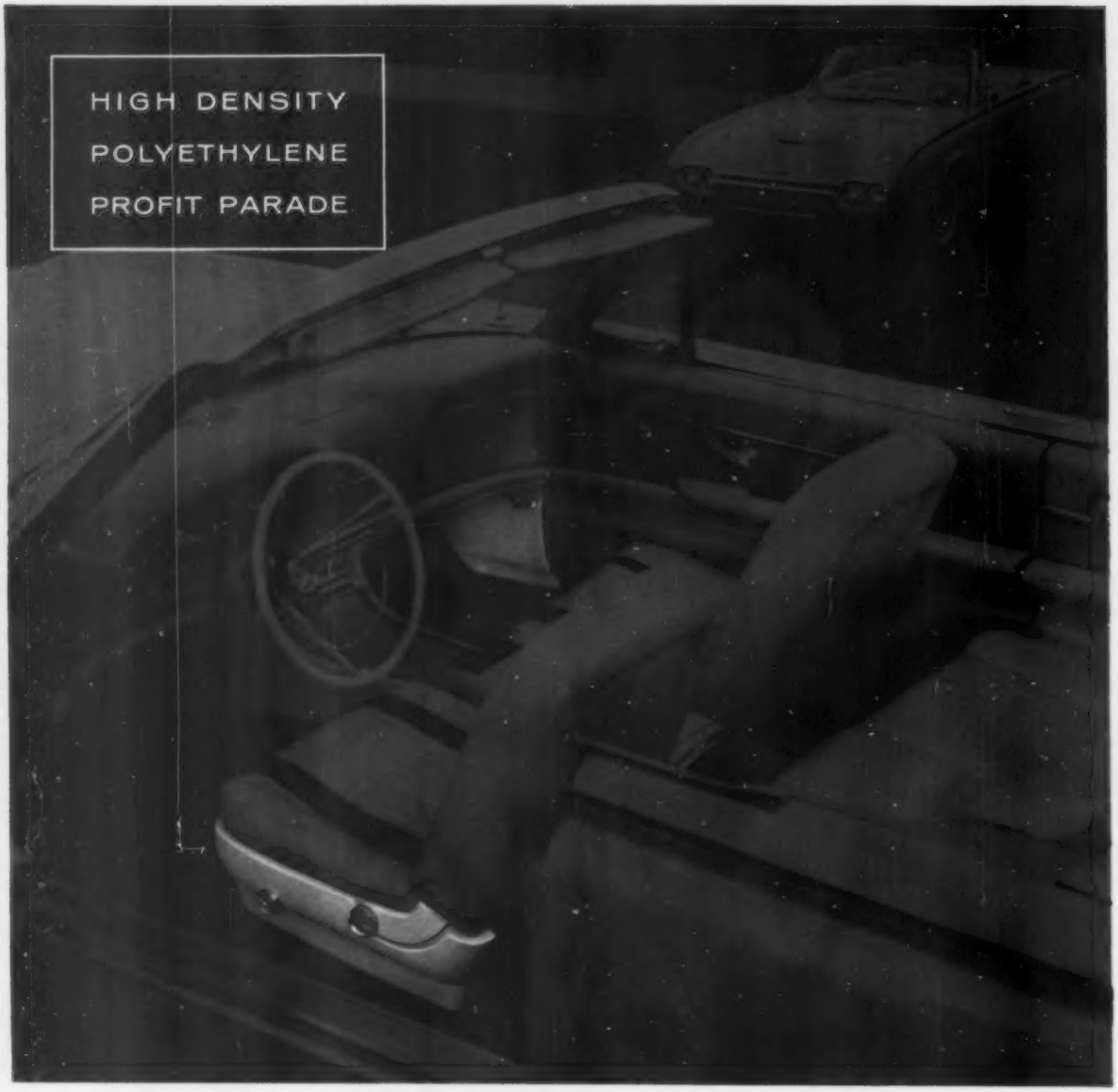

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Example: Grex High Density Polyethylene is a material used in three "show" parts of this '61 model—in the side cowl cover, the side seat shield, and the pivot cap on the seats. Besides having smooth beauty, these parts also must be scuffproof. And they must be perfectly color-matched with other parts of the interior.

Grex is an excellent material for components such as these, where beauty, duty and economy of fabrication must go hand in hand. Grex can be formed by any conventional fabricating technique, in any color. It takes day-after-day punishment without chipping, cracking or breaking. It can undergo extremes of temperature without losing its strength or shape. And most important of all, it adds beauty and value to this car.

If you need the special advantages of high density polyethylene, don't overlook the experts. Grace has the production facilities, technical service and experience to help with demanding components problems. And we're easy to do business with.

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CLIFTON, NEW JERSEY

'61 Thunderbird sets
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Color is critical. As every auto buyer knows, cars are made in almost every color of the spectrum. Ford, in its Thunderbird line alone, uses 6 colors. Grex already has been supplied in all of these approved colors.

Matching colors to the most critical standards requires ingenuity, patience and experience. For colors must not only pass stringent visual tests under the Macbeth light, but must stand the test of time as well.

Wearing qualities essential. There would be little virtue to parts made of Grex if they merely appealed to the eye. All the parts are in "wear" locations, and are subject to scuffing or continual flexing. The problem of scuffing is overcome with a handsome, textured, leather-like effect. Scuffs literally "bounce off." This textured pattern was engraved in the irregular surface molds by photo arc.

The side cowl cover presented a special problem. It is thin-gauge, yet has large surface area. High density polyethylene was selected as the material for this part because it resists abrasion, withstands flexing, and has native toughness, even in very thin, large-area sections.

Why not use some other material? High density polyethylene has special advantages in applications like these. It requires no additional surface finish, and gives close color match. It has a warmth and solidity lacking in other materials. It doesn't chip, crack, or peel. Perhaps most important, it maintains economies while actually improving the quality look of components.

What about you? The problems present in this application can be applied profitably in other products. Luggage, for instance. And housewares, appliance components, quality toys. If you'd like a profitable answer to a high density polyethylene question, just write us:

Technical Service Department
Polymer Chemicals Division
W. R. Grace & Co., Clifton, N. J.

Fluorocarbons

(From pp. 107-108)

Also in 1960, Pennsalt Chemicals initiated semi-commercial production of a resin known as "Kynar," a crystalline, high-molecular-weight polymer of vinylidene fluoride. It is said to be mechanically strong, resistant to distortion and creep at low and high temperatures, stable under extremes of weather and ultraviolet radiation, flame resistant, and highly resistant to attack by corrosive chemicals.

Processable by extrusion, injection molding, and compression molding, Kynar is cited as a possibility for these applications, among others: wire and cable jacketing, pipe and tubing gaskets and seals; coatings for drums and containers; and sterile packages for food, pharmaceuticals, and medical instruments. The Kynar resin is offered at a test price of about $6 a pound.

APPLICATIONS FOR fluorocarbon plastics in 1960 remained primarily within the established and as-yet-unsaturated markets. A recent estimate places about 35% of all fluorocarbon plastics in gaskets and seals (one of the original fluorocarbon applications), followed by 30% in electronic equipment components and 25% for wire and cable jacketing. These fluorocarbon end-uses fall predominantly into the chemical, electrical, and electronic industries, with military applications a large factor in each industry. However, some of the potential applications mentioned above will be in new markets, and these should broaden the base for usage and, consequently, lead to increased production of both the new and older fluorocarbons.

Among the specific new applications for fluorocarbons last year were the following:

A woven TFE fabric lining for the rod-end bearings of commercial helicopters was introduced. The liner eliminated the need for lubrication, and the new bearing has reportedly outlasted lubricated counterparts by nearly five times. TFE material has also been studied for use as an expendable heat-absorbing shield for manned, high-speed rocket flights.

CTFE resin plays an important role in missiles and rockets as a seal for liquid oxygen tanks, because the plastic retains its flexibility at extremely low temperatures.

Glass cloth impregnated with TFE appeared on the market last year, and was put to use in nonsticking conveyor belts for the food and candy industries.

Use of TFE resins in commercial dairy equipment received virtual across-the-board approval by the Food and Drug Administration, opening the way for possible applications in gasketing, filling spouts, and lined equipment.

In the medical field, a CTFE plastic (Minnesota Mining's Kel-F) saw application as a non-wettable, autoclavable blood filter for use in open-heart surgery. A 1-in. thick molded disk of CTFE was machined so that a circular area only ¼-in. thick was formed within the disk. This thin-wall section was then made transparent by heating and rapid quenching, thus permitting visual detection of highly dangerous air bubbles that might appear in the circulating blood.

Other new products made of fluorocarbon resin last year included: a protective suit woven from TFE fiber, for atomic energy and missile applications (the material resists attack by practically all chemicals, will not leak, and can be impregnated with fluorocarbon elastomer to provide gas resistance); needle valve stem tips of CTFE, which eliminate metal-to-metal scoring of valve seats and improve control of corrosive acids and gases; multiconductor cable, in which TFE is used for primary jacketing, FEP for outer covering; a film of CTFE used in electroluminescent lighting applications by General Electric; and an aluminum foil-TFE resin combination (the resin is cast on both sides of the foil and fused at 900° F.). This latter material will be used as a separator in electronic components and as a mold-release film for the plastics industry.

IN THE OPINION of fluorocarbon processors, extrusion is far and away the most widely used method, one estimate stating that probably 70% of all resins are processed in this manner. It is believed that compression molding accounts for another 15 to 20%, with injection molding, dispersion coating and impregnation rounding out the processing picture.—*End*

Phenolics

(From pp. 108-112)

vary in fillers, molding properties, resistance to humidity or moisture, odor, curing time, color, resistance to soaps and detergents.

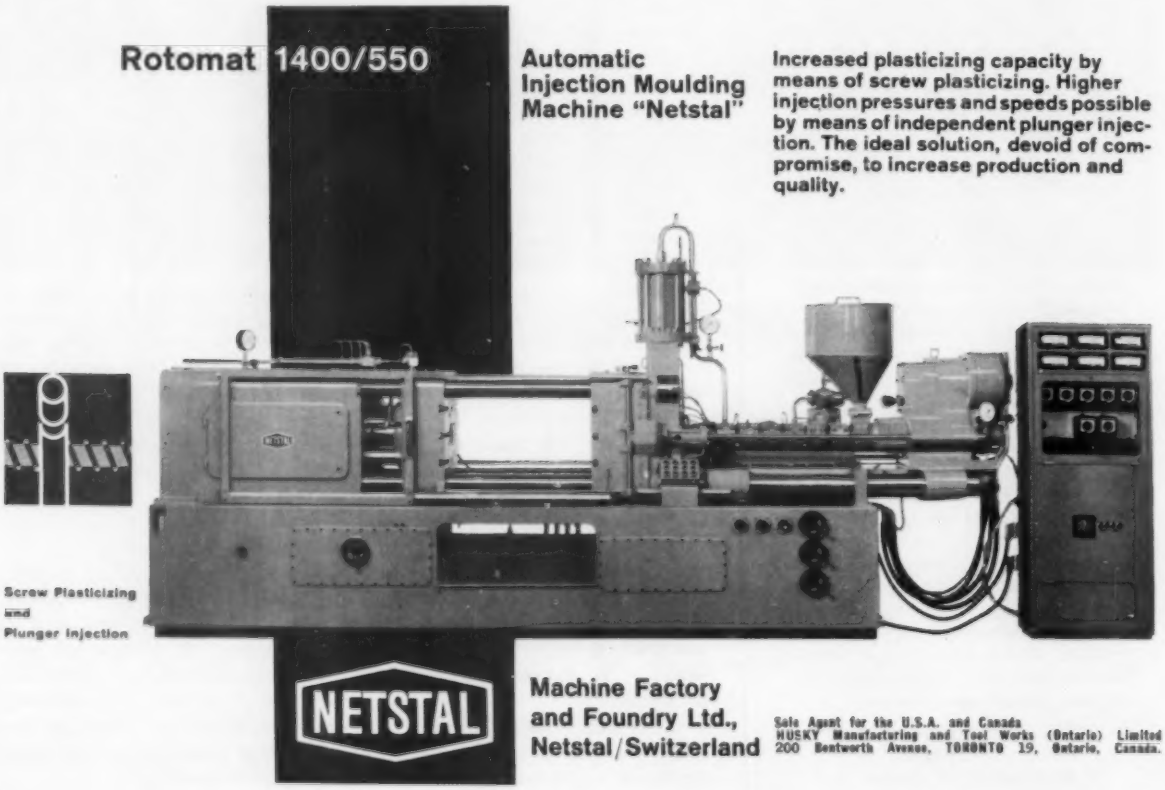
The end-use consumption pattern of phenolic molded products has not varied to any extent over the last several years. General electrical devices such as switch gear, panel boards, wiring devices, and other equipment used in electrical production and servicing have been running from around 75 to perhaps 85 million lb. a year and thus constitute about 40% of total production. In 1960 this market ran about the same in volume as in 1959, but it could be that electrical applications will account for a larger *percentage* of entire phenolics consumption if other end uses should decline. There is no present reason to expect a serious decline in this field even though urea and vinyl chloride have bitten into the wiring device area. Continuous growth in production of electrical components should increase the use of phenolics, since nothing yet has come along to match their heat resistance, electrical properties, moldability, and low cost.

The next largest outlet is appliance knobs, handles, and housings; here again, heat resistance is a predominant factor. There have been various attempts to apply color in this field, either with melamine or coated phenolic; but, so far, there has been little progress. Appliance producers and retailers are not anxious to increase their inventories by carrying a line of colored appliances that will suit the whim of each individual housewife. In any case, this field has been a growing one for phenolics from year to year because handles on electric irons, pans, etc., have been larger. Phenolic consumed in this application was an estimated 20 to 25 million lb. in 1960, thus reflecting the good health of the small appliance industry in contrast to that of large appliances such as refrigerators.

Closures is another large market, but estimates are confusing. Total thermosetting material used in 1960 was around 30 million lb., but 40% of this could have been urea. Thermoplastics have cut heavily into this field and have prevented phenolics from growing. A serious threat has been the loss of a producer of whiskey bottle caps, who is changing over from phenolic. Liquor bottle caps have been a mainstay of the phenolic closures business.

Telephones once consumed around 10 million lb. of phenolic, but this has been cut almost in half over the last several years because of the use of thermoplastics in hand sets. In other communications, such as television and radio, phenolic is used to the extent of 6 to 8 million pounds. Electricals in automotive use require 8 or 10 million lb. a year of phenolics, although smaller amounts in compact cars may reduce volume.

Washing machine agitators that contain 3 to 5 lb. of phenolic, and also fixtures for their wiring, used an estimated 11 million lb. in 1960. Chemical resistance is an important property here. Several other plastics have been after this market, but so far they *(To page 209)*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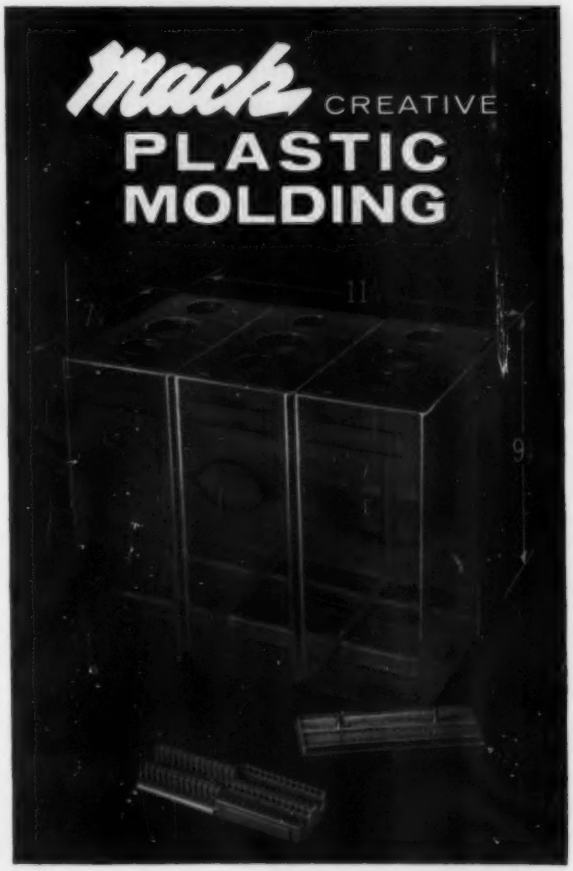

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The price for all liquid phenolic resins was increased from one-half cent to varying amounts on a liquid basis last fall. The lowest price is now 18½¢, with cresol types at 22¢ to 25 cents. Liquid resins are used primarily for laminating, compreg, and battery separators.

Solid resins in the industrial class (pulverized) went up generally by 1½¢ lb. at the same time. These are used in thermal insulation, underpadding on rugs or auto floor mats, brake linings, grinding wheels, and coated abrasives. It is a 24¢ or 25¢ resin.

The price for foundry and shell molding phenolics went up 1¢ and is now around 27½ cents. Total volume for 1960 is estimated at around 25 million lb., about the same as 1959, with several firms putting in new molding lines that will handle it. Nearly all automotive firms now have shell molding lines after hesitating for several years before discarding their old casting equipment. Other resins, such as urea furfural, are potential competitors, and if the auto industry adopts aluminum engines, shell molding won't be needed.

Abrasives and friction materials in 1960 are less than 1959, largely because of a decline in the metals trade. Abrasives for use in grinding wheels and coated materials showed a production figure of 8.2 million lb. in the first half of 1960 vs. 8.4 in 1959, but fell below that figure in the last half when the steel industry failed to pick up. Friction materials reported were only 6.5 million in the first half of 1960, against 8.3 million in 1959.

Use of phenolic in plywood glues was off considerably in 1960, due to a drop in construction usage. A typical news comment on the plywood situation was presented late in November in an announcement that nine mills in Oregon had instituted further cutbacks, closed for one- or two-week periods, and reduced production to about 60% of capacity from the going rate at that time of 70 percent. The moves reflected continuing price weaknesses in the plywood field. However, the drop in phenolic glue would be greater, except that a greater percentage of plywood is now exterior grade which requires phenolics instead of the blood or soya type glues used for interior plywood. The percentage of exterior grade for Douglas fir plywood in the first quarter of 1960 went to 30.9 from 28% in 1959. In 1947 exterior grade was 35% of the total; it dropped to 20% in 1949; and, since 1951, has varied between 24 to 25 percent. Since 1950 the use of Douglas Fir plywood has tripled, from 2.5 billion ft. up to 7.8 billion in 1959. Of this latter total, 2 billion was exterior footage and 5.6 billion was interior.

The use of resins with wood waste or chips is a slowly growing section of the industry with a promising future. There are several variations involved. One uses granulated wood or wood particles mixed in double-spiral ribbon blenders. This compound is then compressed under pressures usually ranging from 500 to 1200 p.s.i., but which could go up to 10,000 p.s.i. It is most generally produced

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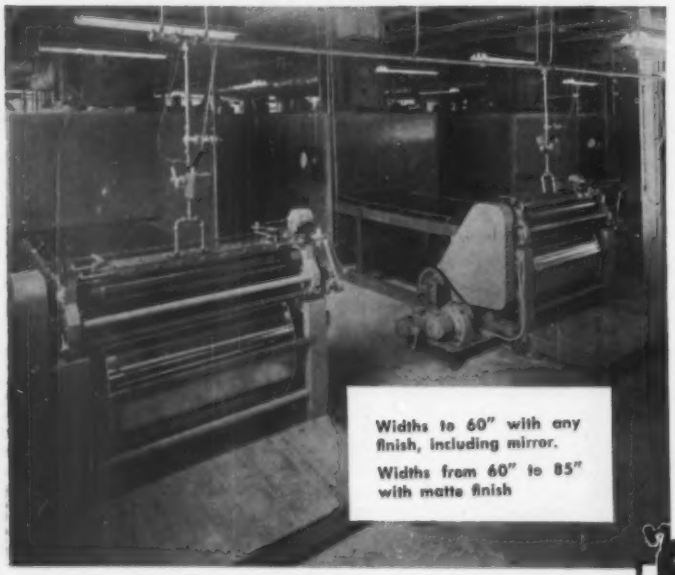

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from furniture factory waste. Phenolics are used in amounts of between 10 and 15% of total weight of the blend. Around 10 million lb. of phenolic or melamine were used for this purpose in 1960, with about 5,500,000 lb. of it in phenolic. Chief products are toilet seats, bowling equipment, desk tops, and institutional furniture.

Another variation in wood waste is particle- and chip-board production. Urea is the predominating resin in this usage, but phenolic use is increasing—in fact, more of it than in wood molding mentioned above—even though the amount of resin used may be less than 5% of the total weight. When phenolic is used, the products can then go outdoors where there is a roof overhang. Of course, it would be painted to offset phenolic's inherently dark color.

Still another variation is hardboard, which is wood pulp, lignin, and phenolic. This is perhaps the largest of the three in square footage production, but the resin composition is small. It is used for such things as peg boards, partitions, and drawer bottoms. It can be used in thinner sections than can particle board and is more tough.

The above application of phenolic in wood is one of its many uses in bonding, which is destined to become one of the most important among its many industrial roles. One producer estimates that this bonding area will increase from 62 million lb. in 1959 to more than 90 million lb. in 1965, with a great portion of the increase in wood and foundry resin uses. This does not include its use as a bonding agent for plywood, laminates, abrasives, and thermal insulation, but does include items given below and estimated number of pounds of bonding resins that were used for this purpose in 1960:

Battery components	5,000,000
Auto filters	8,000,000
Wood compositions	9,000,000
Adhesives	10,500,000
Honeycomb	500,000
Wood waste molding	6,000,000
Reinforced materials	1,500,000
Beaters	1,500,000

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Reinforced plastics

(From pp. 112-114)

companies into the processing end of the business gives promise of the greater financial stability that is virtually indispensable to the realization of profits. As a group, the industry's fabricators have lacked the financial backlog either to build new and improved business or to ride out the effects of periodic market variations.

While diversification has accounted for some big-company investments, more and more of such purchase and construction of molding facilities will be in the nature of rounding-out operations. Take the example of Reichhold Chemicals Inc. Originally involved in the reinforced plastics industry as a resin supplier, this company now not only supplies the other major ingredient, glass, but is a user of its own products—as a manufacturer of paneling. Two other manufacturers of glass reinforcement—Johns-Manville and Owens-Corning Fiberglas Corp.—also have entered the processing field, the first by acquisition, and the second by the construction of facilities for making panels.

Construction rather than purchase of facilities is more likely to be the future avenue of integration of the large-volume producer and end-user industries like the automotive. Such captive operations produce optimum savings when they eliminate shipping costs, and it is seldom that "for sale" facilities are located close to point of final assembly.

INTEGRATION HAS TAKEN PLACE also among reinforced plastics fabricators. The Molded Fiber Glass Companies and Whitehouse Plastics Corp., for example, now produce their own polyester resin. Then there has been the wave of purchases of fibrous glass boat facilities during the past year. Large boat companies, both within and without the reinforced plastics industry, have been involved in this consolidation. Their aims have been to cut themselves in on the still-growing acceptance of fibrous glass boats, or to assure themselves a larger share of this business, or to achieve a better distribution of manufacturing facilities.

Another area where molded reinforced plastics is a "natural" is the truck and bus field, where individual company output is well within the volume needed to afford clear-cut cost savings when using RP. Of the big-name companies, White—and now Diamond T and Ford—are racking up in-use records on the performance of these materials. Many more special body builders have gone, and are going, into the field.

THERE ARE TWO ASPECTS to every successful reinforced plastics application. Repeated and continued emphasis needs to be put on this fact. One is the material itself. The second is how it is used—the particular balance of ingredients and the way they are made into a finished product. Take, as an example, roll-up overhead doors on beverage trucks. Resistance to denting and insulation of the interior from the heat of summer and the cold of winter are properties of the material itself. Continued flexibility that assures repeated easy

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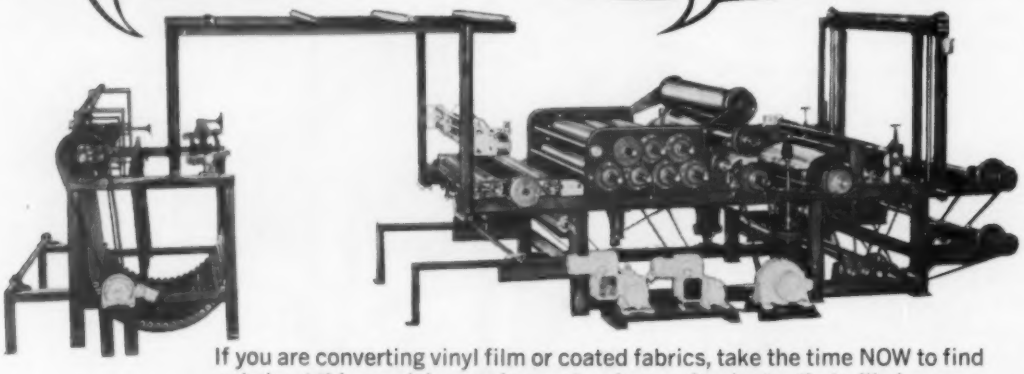

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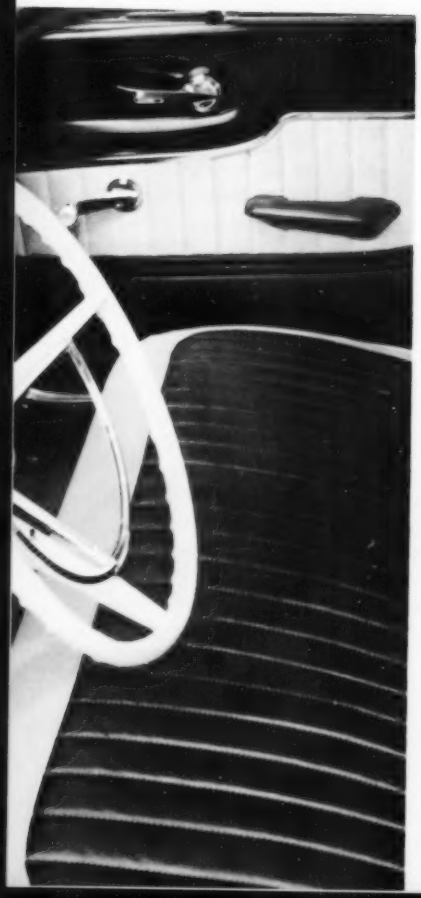

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raising and lowering is, however, a property of the way the material is formulated and fabricated. This is shown by many truck builders' specification of definite types of panels for this use, not just any fibrous glass panels.

As we have noted earlier, molded RP is finding new applications in the passenger car field, and is expected to find more. The will-of-the-wisp is the possibility of its expanded use in the design of car bodies, such as in the Corvette.

A major stumbling block, however, is the present investment of major car companies in steel-processing equipment. The low investment involved in dies for RP parts, though, could well make possible the tailoring of cars to an increasingly segmented market. Further, new models might more economically be produced of reinforced plastics until their popularity was proved and sales reached sufficient volume to justify investment in dies for standard steel bodies.

Poundage of reinforced plastics going into the motor transportation market is expected to increase 18% in 1961, as it did in 1960. Use in aircraft and missiles should be up at least 10%, in contrast to the past 12 months, when approximately the same amount was consumed as in 1959: 37 million pounds.

A DEVELOPMENT WORTH WATCHING in aircraft and missiles is the increased use of pre-pregs. These are ready-to-mold laminating materials, continuous webs of fabric or fiber impregnated with synthetic resins under conditions of extremely close control, which are then advanced or partly polymerized to a point where they can be subsequently laminated to form a product whose specifications are precisely detailed.

These materials offer a solution to two of reinforced plastics' more pressing problems: 1) means of guiding designers and product engineers through the jungle of plastics variables to the right material for the right job, and 2) means of meeting the demand for more critical, reproducible end-product performance.

Today, over 50% of reinforced plastics going into missiles and aircraft is pre-preg material. Accurate reproducibility of properties in part after part is the reason. For commercial applications, pre-pregs serve to minimize the variables and give manufacturers the uniformity that is essential to volume processing, at the same time eliminating much of the hand labor in the fabricator's plant.

These materials also make possible decorated melamine tableware and promise to do the same for decorated closures, with substantial savings to user industries. Chipboard, plywood, even natural wood veneer, are now being given a protective surfacing, thanks to the availability of prepregs.

PANELS CONTINUE as the principal outlet for reinforced plastics in construction, but the reinforced plastics industry still looks on current sales as only a hint of the vast potential volume latent in the construction market when additional applications gain acceptance. Industry continues to view this market as offering the greatest potential for reinforced plastics.

While the poundage of molded RP going into this market will continue to approximate the output of paneling in the immediate future, the ratio of pounds to square footage bears watching. Last year the amount of material going into construction was substantially the same as that reported for 1959. However, production of reinforced plastics paneling actually increased. Estimates are that 80 to 85 million sq. ft. were turned out during 1960, as compared to 70 to 75 million sq. ft. in 1959. The reason for greater production with no increase in materials: a higher proportion of lighter weight panels.

Generally the breakdown of sales of different weights of panel gives 50% to those types weighing 6 oz./sq. ft and under, 40% to 8-oz. panel, and 10% to all other weights. Figuring in the under-6-oz. category is the 5-oz. paneling which has proved increasingly popular in a variety of applications in the residential market.

Another 10 to 15% increase in square-footage production is anticipated by panel manufacturers during the coming 12 months. Besides polyester panels, there will be those made with all-acrylic sirup. Owens-Corning Fiberglas is already in production on this type sheet.—*End*

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Urea and melamine

(*From page 115*)

the appearance in 1960 of films such as diallyl phthalate or polyester, which could be applied clear or reverse-printed directly to a wood or particle board substrate. The consensus was that the immediate effect of the films would be felt in the low-cost furniture field which is now not serviced by the melamine laminates.

TOTAL SALES of urea and melamine resins for plywood—based on U. S. Tariff Commission reports for the first 9 months of 1960 and projected figures for the last 3 months—showed a surprising 20 million lb. drop from 1959 figures. Hardwood plywood, which is the largest user of urea and melamine bonding and laminating resins, accounted for most of the drop. By year's end, it was estimated that the consumption of such plywood had shown a 9% decline for the first three-quarters of 1960—probably as a direct result of the slow-down in construction brought on by the mid-year slump in general economic conditions.

Urea and melamine resins for all other bonding and adhesive uses (including resin used for chipboard and commercial adhesives) showed the year's healthiest increase—up 8 million lb. to a 31-million-lb. figure. Most of the credit for the rise belongs to the estimated 10 to 20% increase in the use of chipboard in 1960. It should be noted, too, that it is probable that the over-all increase in this category may have been even higher than shown in the reported figure. There are many small companies with captive operations involving urea glues for wood working and bonding that do not report to the government.

RESINS FOR PROTECTIVE coatings held the line at 26.5 million lb.—just about even with 1959's 27-million-lb. figure. There was some evidence at the beginning of the year that a number of manufacturers of industrial baking enamels might be swinging to captive production of melamine resins (a more difficult project than the production of urea for glues). But although American Cyanamid did report a few licensees during the year, the trend was nowhere near as emphatic as anticipated. Nor did expected competition for alkyd-melamine baking enamels from such resins as acrylic materialize in the automotive industry in 1960. It is the opinion of melamine producers that the automotive finishes market has not yet shaken down to the point where any one type of enamel will soon be taking over this lucrative market.

In the "resins for all other uses" category, it is estimated that melamine molding materials probably accounted for some 56 million lb., urea molding materials for 38 million lb., exports (all uses) for 25 million lb., and miscellaneous, 5 million pounds. There is a possibility that revised Tariff Commission reports for the last three months of the year may up the total some 4 million lb. to a 128-million-lb. total.

It might be well to note at this point the change in reporting which the Tariff Commission instituted last year when it decided to lump all exports of urea and melamine in "the resins for all other uses" figure, instead of dividing them among various categories. This should be kept in mind when reviewing figures for the past few years as shown in the tables on page 115.

THE DINNERWARE MARKET, backbone of melamine molding powder sales, was off some 5% in 1960. The slight drop in overall sales, however, were not enough to discourage producers from still predicting a 100-million-lb. market for dinnerware by 1965. The break resistance of the melamine dinnerware and more recently its attractive appearance (about 80% of the dinnerware on the market is decorated with a foil overlay) are too good to hold it back for long. Producers figure that there are still some 33.7 million American families that are prime prospects for sales of melamine dinnerware. The institutional markets—restaurants, schools, hospitals, factories, etc.—for dinnerware also still hold great potential.

After another year in which lower-cost thermoplastic tableware has been on the market, it is becoming obvious that the thermoplastics are not going to make any substantial dent in the melamine market. Softer sur- (*To page 217*)

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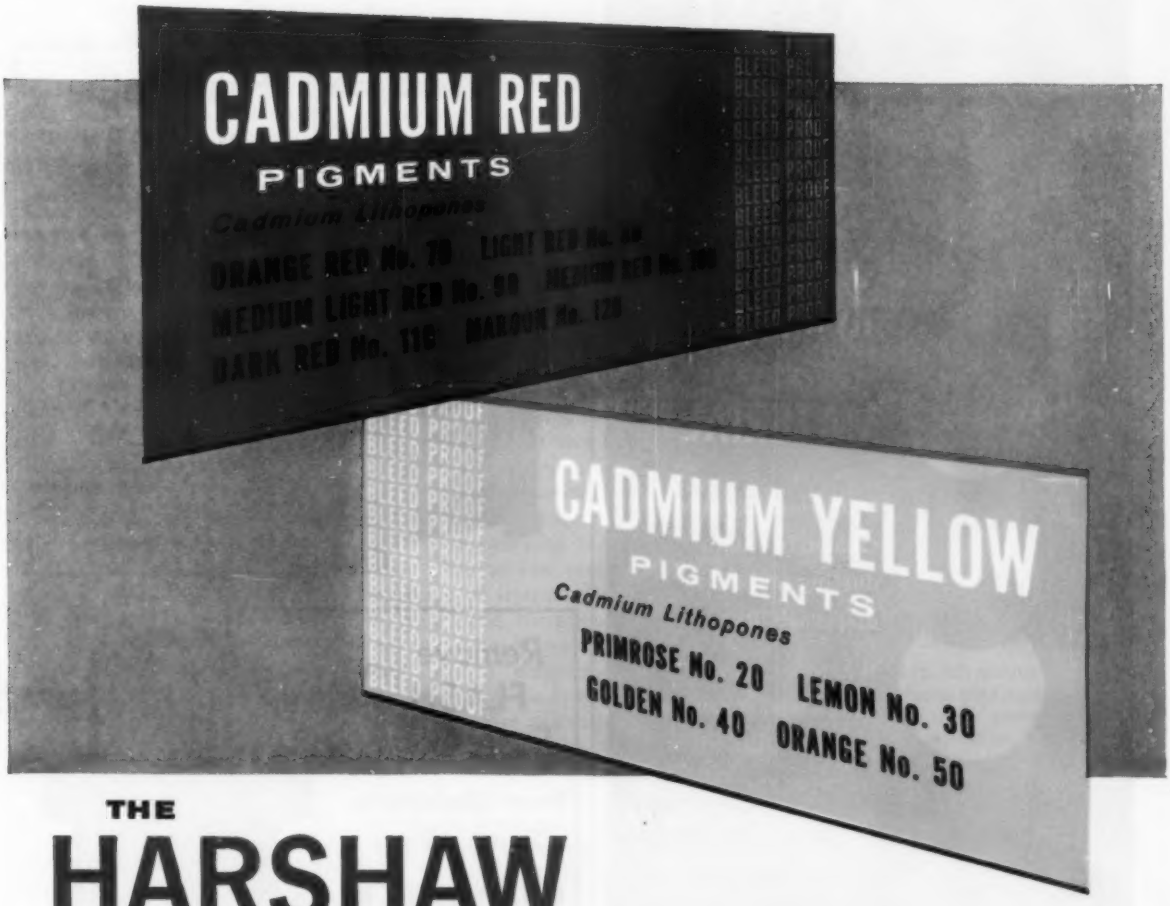

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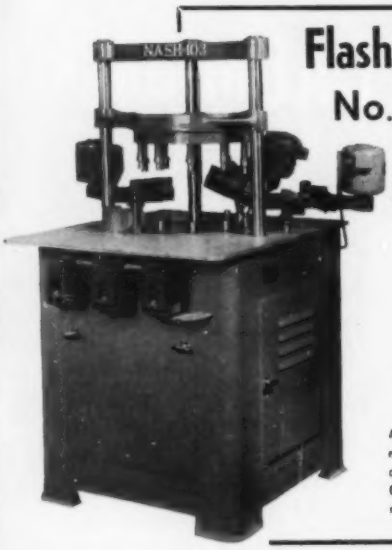

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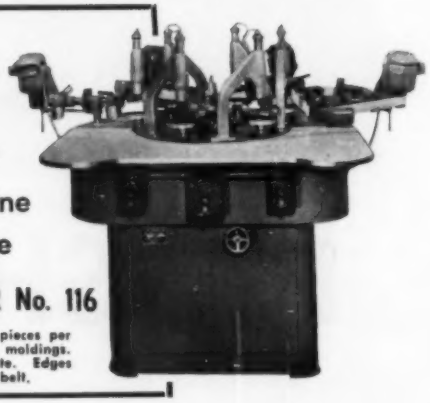

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face, lower heat resistance and difficulty of decorating should keep them out of the quality market which melamine now services.

BUT THE PRICING SITUATION that started to shape up in 1960 caused real concern among melamine suppliers. In January 1958, a 45-piece set sold for $49.95; today, the average is around $29.95 and some retailers are selling dinnerware sets for as low as $16. It is true, of course, that there are some legitimate reasons for lower prices. For one thing, manufacturers have found that they can reduce wall thickness down to the minimum standard (from 0.090 in. for cups up to 0.100 in. for 9¾-in.-diameter plates) without sacrificing quality. In past years, most plastic dinnerware was well above this standard; this year, most of the manufacturers just about met it. (In essence, this meant that although less resin was sold, more pieces were probably produced.) Then too, automation, shorter cycles, and better preheating and molding methods have increased speed of operation by as much as 50% in some plants—and consequently cut costs.

But it was more than likely that the lower prices represented a totally unhealthy competitive situation which had resin suppliers much concerned. Profit margins for both manufacturer and retailer were shrinking down to a dangerous level. Less money was available, too, for advertising or promotion of plastic dinnerware. It was interesting to note in this connection that on November 8, American Cyanamid, followed a few weeks later by Allied, announced a cooperative advertising program in which the resin supplier would pay half of the cost of advertising placed by customers up to a maximum of 2¢ per pound of resin shipped to the customer.

WHAT'S GOING TO HAPPEN IN 1961? For one thing manufacturers expect to see a shake-down in the dinnerware industry. Some marginal producers, unable to function at the minimum profit level, will be squeezed out of the picture; and some consolidation among the remaining companies may show up. The end result should be to buck prices up to a level where everyone —molder and retailer—can make a legitimate profit. An immediate reaction is already anticipated for the January market, when dinnerware prices are expected to rise again.

Other molded melamine applications stayed at virtually the same levels as 1959 and in the same areas —electric shaver housings, housings for appliances, soda fountain sirup jars, cutlery and paint brush handles, and warming dishes. Of interest during 1960 was the first appearance of the molded overlay foil-decorating technique in products other than dinnerware. A decorated melamine kitchen utensil handle and a decorated urea light switch were the year's highlights in this respect. Both prime resin suppliers (American Cyanamid and Allied) also introduced a special molding grade that imparts a high gloss to the finished product. Expectations were that the material would prove useful in cosmetic containers, electric shaver housings —and possibly in dinnerware.

Markets for urea molding powder continued to feel the effects of the invasion of thermoplastics—particularly in the closures market, which now consumes about half of the urea powder produced. At first it was thought that urea had staged a comeback in the closures field this year when several producers of cosmetics packages announced they were switching back to urea after some serious problems with breakage of styrene closures. But, by year's end, these same producers were already evaluating lower-cost molded polypropylene closures as a possible replacement for urea. The other two major markets for urea molding powder—wiring devices and buttons and custom molded applications (e.g., stove hardware, poker chips, a few radio cabinets, etc.)—continued to split the remainder of the market between them.

The new fire-resistant urea introduced last year continued to make headway in 1960—but outmoded building codes in several states slowed it down somewhat. Lighting fixture manufacturers showed the most interest in the material—particularly after a louvre diffuser based on the urea became the first rigid plastic diffuser of this type to be listed by the New York City Board of Standards and Appeals as non-combustible.—*End*

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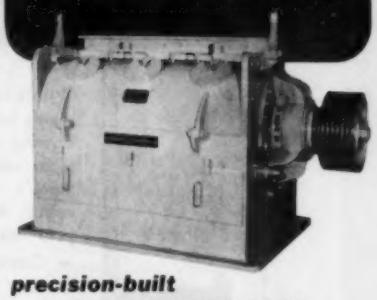

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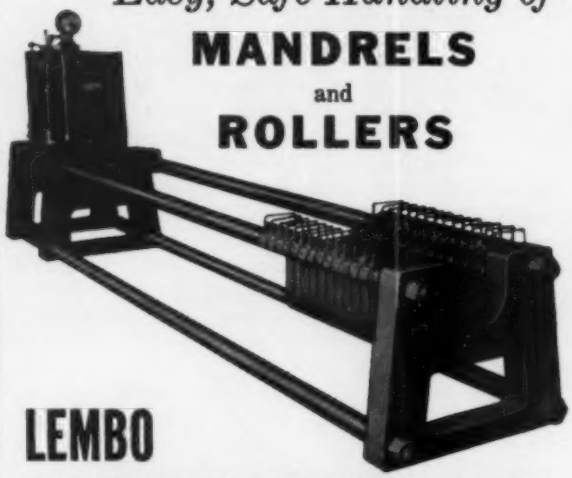

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Engineering highlights

(From pp. 123-138)

plastic products, *"How to specify molded plastic parts,"* by R. L. Miller, *Mat'ls in Design Eng. 51,* 94 (Jan. 1960), points up two problems existing in the specification of plastic materials: 1) the need for materials standardization, and 2) unfamiliarity of the designer or engineer with plastics. This paper is a practical guide in the selection of the plastic and the design, and in getting the performance that is desired from a plastic part at lowest cost. A sample specification sheet is presented with a specification check list. Other papers of value to the molded plastic part designer:

"Design tips for polyolefin parts," by J. N. Scott, J. V. Smith, and D. L. Alexander, *MPI 37,* 130 (June 1960), which explains the beneficial effect of ribbing, curved surfaces, rounded edges, and fluting in reducing part warpage using polyolefin resins; *"The polypropylene hinge: long life at low cost,"* by M. W. Riley, *Mat'ls in Design Eng. 52,* 117 (Oct. 1960), which presents detailed design know-how on how to use molded-in hinges in polypropylene parts. No one knows exactly why the flex resistance of polypropylene is so good, but three case histories speak for its suitability as a long-life hinge.

"When plastic cams are better," by M. A. Sanders, *Prod. Eng. 31,* 44 (Aug. 8, 1960), explains the factors to be considered in deciding to use a molded plastic cam. In quantities of over 100, molded cams can often be made with higher quality and uniformity than can machined steel cams.

In the application of reinforced plastics, both *"Low-pressure reinforced plastics,"* by M. W. Riley, *Mat'ls in Design Eng. 51,* 103 (Feb. 1960), and *"Presenting creep data on reinforced plastics,"* by E. Van Antwerp, *Plastics Tech. 6,* 44 (June 1960), will be of value to the plastics designer. The former is a 16-page basic survey of the reinforced plastics field. Topics include: resins, reinforcements, processes, effects of processing variables on properties, short- and long-term properties. The latter discusses two methods for reporting stress-rupture data on reinforced plastics. Included are graphs and tables with creep data on epoxy- and polyester-fibrous glass laminates at various temperatures. Data indicates changes in stress can cause significant differences in time to rupture.

In the thermoplastic design field, *"Structural design of plastics,"* by E. Baer, T. J. Linton, R. E. Maier, and J. R. Knox, *SPE J. 16,* 396 (April 1960), presents an explanation of the significance of plastics physical-property test data in design problems. Part II of the paper discusses design methods and illustrates the use of data by means of several concrete examples using parts of simple geometry.

For molders making plastic shoe heels, the paper, *"Evaluation tests for plastic heels,"* by E. E. Joiner, J. P. Szumski, and F. J. McGarry, *MPI 37,* 152 (March 1960), describes the test equipment used in impact, nailing, and flexural fatigue resistance testing of ladies' high heels and discusses the significance of typical test results.

Designers of optical equipment will find of interest *"Use of allyl by-products for optical instruments,"* by R. Grand Perret, *Ind. Plast. Mod. 12,* 41 (Oct. 1960). In French. Article describes molding techniques, design, and properties of optical lenses made from diethylene-glycol bis-allyl carbonate.

A new recording principle is described in *"Thermoplastic recording,"* by W. E. Glenn, *J. Appl. Physics 30,* 1870 (Dec. 1959), which makes use of a low-melting-temperature plastic tape. An electron beam is used to impress a charge pattern on the specially coated surface of the plastic tape in accordance with the intelligence to be recorded. The film is then heated in a vacuum to develop thermal deformations in the surface which will reflect light. These deformations are read with a photoelectric-optical system to generate an electrical output which corresponds to the recorded signals.

Finally, a meaty design information article is *"An evaluation of special-purpose adhesives," Electrical Mfg. 65,* 125 (Jan. 1960). The paper explains what adhesives to use for bonding plastics to plastics, plastics to rubber, plastics to metal, and other materials to each other. Specific adhesives are listed in tabular form, along with their purpose and some properties.—*End*

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1960 in review

(From pp. 141-156)

including specific data for PE (151-155), nylons (185), chlorotrifluoroethylenes (102), polymethyl acrylate (571), and laminates (572). Methods were described for the measurement of cure (60-63, 573), crosslinking (234), and wettability of plastics (98, 104, 574, 575), polyethylene printability (435), static charges on plastics (434), photoelastic properties of polystyrene (216), specific heats (576), and film clarity (577). Evaluation tests were proposed for plastics heels (474), PVC-coated fabrics (270), and quality control of reinforced plastics (369) and of vinyl (578) and tetrafluoroethylene (579) electrical tubing.

Analytical procedures were published for determination of the composition of acrylic plastics (46-51), polyester resins (194-196, 580), hydrocarbon copolymers (170, 581), polyvinyl chloride compositions (267), polyamides (186), rosin derivatives (321, 322), and bisphenol A (582). New spot tests for phenolic, melamine, styrene, epoxy, chloroprene, and chlorinated rubber (583) will assist in the identification of polymeric materials commonly encountered in commercial products (584). Methods useful in examination of plastics, rubbers, and fillers by optical and electron microscopy (585) and gas-liquid chromatography (586) were described. A systematic nomenclature was proposed for diisotactic polymers now available through the application of stereospecific catalysis (587).

Standards—A.S.T.M.

In record-breaking activity during 1960, A.S.T.M. Committee D-20 on Plastics (588) completed nine new methods of test, six new specifications, and a new recommended practice, as well as revisions of eleven test methods, three specifications, and three standards for nomenclature and abbreviations. The new test methods were for particle size analysis of vinyl chloride polymers (D 1705), Durometer indentation hardness (D 1706), microtensile properties (D 1708), impact resistance of polyethylene film by the free-falling dart method (D 1709), resistance to sulfide staining (D 1712), gas evolved from blowing agents (D 1715), welding performance of PVC structures (D 1789), brittleness temperature of plastic films by impact (D 1790), and transparency of plastic sheeting. The new specifications were for polytetrafluoroethylene rod (D 1710), rigid polyvinyl chloride compounds (D 1784), International Pipe Standards rigid polyvinyl chloride pipe (D 1785), toluenediisocyanate and polyoxypropylene glycol (D 1786), rigid acrylonitrile-butadiene-styrene resins. The new recommended practice that was approved provided for uniform presentation of capillary flow data on molten thermoplastics (D 1703).

Three new tentative standards were approved by A.S.T.M. Committee D-14 on Adhesives (589):

563. "Measurement of concentration gradients for diffusion of vapors in polymers," by D. Richman and F. A. Long, J. Am. Chem. Soc. 82, 509 (Feb. 5, 1960).
564. "Concentration gradients for diffusion in glassy polymers and their relation to time dependent diffusion phenomena," by F. A. Long and D. Richman, J. Am. Chem. Soc. 82, 513 (Feb. 5, 1960).
565. "Permeation of water vapor through polymeric films," by J. E. Ayer, D. R. Schmitt, and R. M. Mayfield, J. Appl. Poly. Sci. 3, 1 (Jan.-Feb. 1960).
566. "A new calibration technique for gas transmission measuring apparatus," by T. McAvoy, ASTM Bull. No. 243, 52 (Jan. 1960).
567. "Adsorption of water vapor by unsupported organic films," by W. H. Slabaugh, C. N. Spalaris, L. E. Holboke, and L. E. Hoag, J. Appl. Poly. Sci. 2, 241 (Sept.-Oct. 1959).
568. "The permeability of unoriented polymer films," by C. H. Klute, J. Poly. Sci. 41, 307 (Dec. 1959).
569. "Small molecule diffusion in cold-drawn or stretched polymer films," by W. W. Brandt, J. Poly. Sci. 41, 415 (Dec. 1959).
570. "Permeability of various polymers to 90% hydrogen peroxide," by H. J. Dietrick and W. W. Meeks, J. Appl. Poly. Sci. 2, 231 (Sept.-Oct. 1959).
571. "Concentration and temperature dependence of diffusion coefficients for systems polymethyl acrylate and n-alkyl acetates," by H. Fujita, A. Kishimoto, and K. Matsumoto, Trans. Faraday Soc. 56, 424 (Mar. 1960).
572. "Diffusion of water vapor in plastic laminates," by E. R. Hosler, J. F. Chivot, P. J. Korpi, and J. W. Westwater, J. Chem. Eng. Data 5, 164 (Apr. 1960).
573. "An apparatus for the measurement of gelation times," by W. J. Ross and C. H. Wright, Brit. Plastics 33, 378 (Aug. 1960).
574. "Study of wettability of polymers by sliding of water drop," by K. Kawasaki, J. Colloid Sci. 15, 402 (Oct. 1960).
575. "Wetting of polymethyl methacrylate and polystyrene by water and saliva," by R. G. Craig, G. C. Berry, and F. A. Peyton, J. Phys. Chem. 64, 541 (May 1960).
576. "Specific heat of high polymers," by R. M. Warfield, M. C. Petree, and P. Donovan, SPE J. 15, 1055 (Dec. 1959).
577. "A meter for film clarity," by P. M. Hay, C. P. Evans, and R. W. Ninneman, Modern Packaging 33, 179 (Nov. 1959).
578. "A new grade of low temperature vinyl electrical insulating tubing," by L. E. Seiffert and H. K. Graves, Insulation 6, 45 (Sept. 1960).
579. "Control of quality non-rigid polytetrafluoroethylene tubing," by H. K. Graves and L. E. Sieffert, Insulation 6, 28 (Apr. 1960).
580. "Polarographic determination of terephthalic acid in mixtures of phthalic acid isomers," by M. E. Hall and R. C. McNutt, Anal. Chem. 32, 1073 (Aug. 1960).
581. "Determination of copolymer composition by combustion analysis for carbon and hydrogen," by L. A. Wood, I. Madorsky, and R. A. Paulson, J. Res. NBS 64A, 197 (Mar.-Apr. 1960).
582. "Paper chromatography of bisphenol A," by G. Challis and P. H. Hermand, Anal. Chem. 32, 778 (June 1960).
583. "Spot tests for plastics," by F. Feigl and V. Anger, Modern Plastics 37, 151 (May 1960).
584. "What plastic is it," Modern Plastics 37, 88 (July 1960).
585. "Microscopic examination of rubbers, plastics, and fillers," by M. Stephens, and N. H. Langton, Plastics 25, 329 (Aug. 1960).
586. "New uses for gas-liquid chromatography in plastics," by W. H. Parrish and P. D. Holland, Brit. Plastics 33, 372 (Aug. 1960).
587. "Proposed nomenclature for diisotactic polymers," by G. Natta, M. Farina, and M. Peraldo, J. Poly. Sci. 43, insert (Apr. 1960).
588. "Report of A.S.T.M. Committee D-20 on Plastics," Proc. A.S.T.M. 60, preprint (1960).

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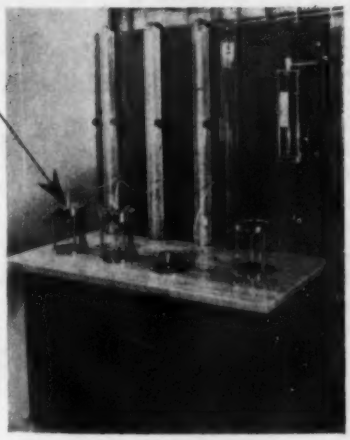

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method for climbing drum peel test for adhesives (D 1781); specification for adhesive for acoustical materials (D 1779); recommended practice for conducting creep tests of metal-to-metal adhesives (D 1780).

Four new or revised Commercial Standards for plastics products were approved during 1960 as follows: flexible polyethylene pipe (CS197-60); rigid unplasticized PVC pipe (CS207-60); plastic drain and sewer pipe and fittings (CS228-60); vinyl plastic weatherstrip (CS230-60). Six proposed new or revised Commercial Standards have been circulated to industry for approval, as follows: corrugated plastic structural panels (TS-5485, Apr. 1, 1960; a revision of CS214-57); polytetrafluoroethylene sheet (TS-5488, Apr. 12, 1960); polytetrafluoroethylene cast film (TS-5490, May 25, 1960); polyethylene sheeting for various applications in construction, industrial, and agricultural applications (TS-5501, Aug. 1, 1960); polytetrafluoroethylene cast molded basic shapes (TS-5509, Sept 23, 1960); tetrafluoroethylene-fluorocarbon resin skived tape (TS-5513, Oct. 13, 1960).

Standards—ISO

Technical Committee 61 on Plastics of the International Standardization Organization completed action on five Draft ISO Recommendations at its 1960 meeting in Prague, and approved three new Draft ISO Recommendations and five Draft Proposals (590). This brings to 40 the number of international standards on plastics that have reached preliminary or final form during the first 10 years of operation of ISO/TC 61, representing the cooperative efforts of plastics engineers from 21 participating countries. The new Draft ISO Recommendations describe methods for the determination of stiffness, tensile properties of plastics, and curing characteristics of polyester resins. The Draft Proposals relate to determination of water content, relative viscosity, and percentage of monomer and low molecular weight polymer in polyamides, resistance to changes in color that are caused by natural light, as well as change of mechanical properties after coming in contact with various chemicals.

The American Standards Association, the United States Member Body of ISO, has advised ISO/TC 5/SC 6 on Plastics Pipes and Fittings that this country will now take a participating rather than an observer role in the activities of that subcommittee. Documents considered at the meeting of ISO/TC 5/SC 6 in Paris on November 14-18 included a proposed inch series of recommended minimum outside diameters for plastics pipes for incorporation in Draft International Standards Organization Recommendation No. 282, which is entitled "Pipes of Plastic Materials for the Transport of Fluids," drafts of specifications for polyvinyl chloride and polyethylene pipes, as well as proposed test procedures and specifications for long-term burst tests.—*End*

589. "Report of A.S.T.M. Committee D-14 on Adhesives," Proceedings A.S.T.M. 60, preprint (1960).

590. "Tenth meeting of ISO/TC 61 committee on plastics," Modern Plastics 38, 156 (Dec. 1960).

THE PLASTISCOPE*

News and interpretations of the news

By R. L. Van Boskirk

Section 2 *(Section 1 starts on p. 39)*

January 1961

Prospects for plastics in packaging films

Total yearly sales of transparent films will grow 67%—an increase of about 465 million lb.—by 1965, according to a forecast by Paul Murphy, general manager of packaging market sales of Reynolds Metals Co., at the Western Packaging and Materials Handling Exposition in Los Angeles, Calif. Plastic films will account for at least 82% of this increase—with polyolefins and specialty films pacing the upsurge. Statistics compiled by the Reynolds market research department indicate that about 64% of all flexible film sold is used for packaging. Mr. Murphy took charge of Reynolds plastic film packaging sales recently when the plastics department was given full divisional status.

"Annual sales of water-soluble PVA film will soar to 11 million lb. by 1965," Mr. Murphy said, "and oriented PVC film sales will reach 10 million lb. in the same period." He said 1960 industry sales of the two films will total slightly more than 1 million lb. each. "Consumer demand for convenience and portion control will make packets of water-soluble film for soaps, detergents, and dry bleaches a standard item on grocery shelves throughout the nation," he said. "Through recent improvements, PVA now provides the product long sought by the home laundry industry—an economical, non-brittle film that runs well on packaging machinery and dissolves quickly in hot water."

Several of the commercial packages on display at the Exposition using Reynolon PVC overwraps demonstrate the wide range of products which can benefit from the clarity, skin-tight cling, and protective qualities of the film. They included Capitol's Angel phonograph records. Armour Star bacon, frankfurters, apples in a pressed board tray, baked goods in an aluminum foil tray, and textile products.

*Reg. U.S. Pat. Off.

Government figures for PE

Differences in estimates for consumption of polyethylene are illustrated by comparing a special summary produced by the government's Business and Defense Services Administration on this page and the MODERN PLASTICS table on page 86. The BDSA figures were derived from those accumulated by the Tariff Commission and represent an effort to ascertain how much polyethylene capacity would be available in the event of a national emergency.

Totals for "all" polyethylene in 1958 and 1959 are almost in complete agreement with MODERN PLASTICS figures. But when the total is separated into the various end-use categories, there is considerable difference between the two sets of figures. MODERN PLASTICS estimates were obtained largely by personal interviews with sales managers and market analysts of various producers and processors of polyethylene. The BDSA figures were obtained through a survey made by individuals of that organization.

It is difficult to make a direct comparison, since the MODERN PLASTICS survey does not "break out" the resin handled by reprocessors. In this magazine's survey such

Distribution of polyethylene by end-uses, 1958-59 (Quantity in million lb.)[a]

	1958						1959					
	Domestic		Exports		Total		Domestic		Exports		Total	
Use	Quantity	% of total	Quantity	% of total	Quantity	% of total	Quantity	% of total	Quantity	% of total	Quantity	% of total
Film and sheet	233	39	53	21	286	33	334	40	61	20	395	34
Injection molding	97	16	32	13	129	15	121	14	35	11	156	14
Blow molding	21	4	3	1	24	3	37	4	3	1	40	4
Extrusion, wire and cable	80	13	4	2	84	10	115	14	5	2	120	10
Piping	24	4	6	2	30	3	31	4	13	4	44	4
Miscellaneous extrusions	[b]	[b]	[b]	[b]	15	2	[b]	[b]	[b]	[b]	7	1
Coatings	[b]	[b]	[b]	[b]	43	5	[b]	[b]	[b]	[b]	67	6
Wax additives and monofilaments	[b]	[b]	[b]	[b]	9	1	[b]	[b]	[b]	[b]	11	1
Miscellaneous	[b]	[b]	[b]	[b]	110	13	[b]	[b]	[b]	[b]	116	10
Reprocessors and dealers	75	12	51	20	126	15	97	12	92	30	189	16
Totals	604	100	252	100	856	100	835	100	310	100	1145	100

[a] This table was prepared by the Business & Defense Services Administration of the U.S. Dept. of Commerce. [b] Withheld to avoid disclosing figures for individual companies.

News about R&A SINCE 1913 **Adhesives**

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In between, more than a score of BONDMASTER epoxy-based adhesives offer a wide range of handling characteristics, curing cycles, and differing degrees of tensile strength, flexibility, heat-resistance, etc.

"ROOM TEMP" OR HEAT-CURING

Some of these products cure at ambient temperature, some require heat. Some are versatile enough to permit their use both ways: there's one room-temperature-curing formulation which reaches "handling strength" in about six hours but which can be cured in as little as 10 minutes at 150°F. . . . even more swiftly at higher temperatures. (None of the 100%-reactive formulations require any more pressure than is needed to maintain contact during cure.)

END-USE SERVICE CHARACTERISTICS

These formulated epoxy adhesives will bond *all* metals and almost all plastics to themselves or to each other . . . or to wood, ceramics, or just about any other materials, for that matter. As a group, they exhibit minimal shrinkage, are electrical insulators, and provide excellent resistance to weather, galvanic action, and most chemicals, acids, and alkalies.

They are available as liquids, pastes, mastics, syrups, films, and powders . . . yielding tensile strengths among the highest attainable within the scope of present-day adhesive technology.

•

Write for Technical Data Sheets detailing adhesive laydown, curing cycles, bonding methods, etc., of BONDMASTER Series "M" Structural Adhesives.

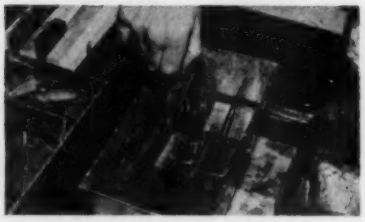
R&A SINCE 1913

RUBBER & ASBESTOS
CORPORATION
243 BELLEVILLE AVENUE
BLOOMFIELD, NEW JERSEY

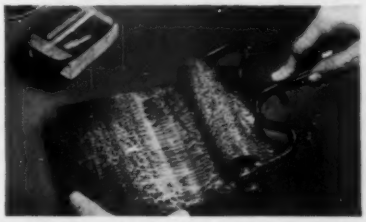
"Styrofoam" to magnesium (M685)

Phenolic to brass (M648T)

Silicon steel laminates (E645)



Rotary solenoid stators (E621)



Alnico magnets to zinc castings (M620)

High impact polystyrene to aluminum, copper, neoprene (M648)

Galvanized steel to aluminum (M688)

•

If the handling characteristics of the adhesive you are using don't match your most efficient production demands, chances are there's a standard BONDMASTER formulation that will! If you will detail your problem, we'll be glad to send samples . . .

THE PLASTISCOPE

(From page 222)

resin is included in the various "end-uses" where it is consumed. It is also noted that the miscellaneous category is much larger in the BDSA survey. This category, too, was divided among its various "end-uses" in the MODERN PLASTICS summary. Another difference is that the BDSA export figures are broken down into end-use classifications, MPI's figures are not. This breakdown may have been the greatest guessing game in the Twentieth Century, for it is difficult to believe that Americans can be sure of what their exported resin is used for in as definite a pattern as shown in the government figures.

The greatest discrepancy between the BDSA and MODERN PLASTICS tables is in film. Supposedly, this represents resin used for film and is not necessarily actual film. In other words, the 3 to 10% waste accumulated in processing is included in both surveys. The government export figure for film, however, when subtracted from the total of 395 leaves 334 million lb. for domestic consumption which is almost the same as the MODERN PLASTICS figure of resin consumed for domestic film. But as noted in the section on polyethylene, starting on page 85, there is some question as to whether or not more than 310 million lb. of finished film actually went to market in 1959.

These examples illustrate the differences between the two tables and adjustments that have to be made by any reader who attempts to reconcile them.

Flexible epoxy resins

A new series of low-cost, tough, flexible epoxy resins, said to be particularly suitable for thermal shock-resistant encapsulation and metal-coating, have now been made possible through the use of a new catalyst in conjunction with a recently introduced epoxide and dimer or trimer acids. The new resin system, developed by Union Carbide Chemicals Co., when compounded, runs about 48¢/lb., compared with 60 to 80¢/lb. prices for compounds based on the conventional epoxies.

The reaction mixture gels rapidly and exothermally at temperatures between 80 and 120° C., and cross-linking takes place. Resins made from 0.5 carboxyl group for each epoxide group have tensile-elongation properties ranging from 7000 p.s.i. at 15% elongation to 2000 p.s.i. at 100% elongation. They are reported to show little change in physical properties after aging at 120° C. for 2000 hours. Resin castings made from dimer acids are flexible; trimer acids give harder resins. Carbide anticipates that the system will find particular use in encapsulation of motor stators, coils, and other electrical components.

Carbide is selling the basic Unox 201 epoxide monomer and has tentative plans, as a customer service, to sell the epoxide with 1 or 2% catalyst as a stable mixture. The dimer or trimer acids must be obtained elsewhere.

The resin system will cure in 1 hr. at 120° C. or in one week at room temperature. It has a pot life of 4 to 8 hr.; it can be sprayed at room temperature as 80% solids, or as 100% solids when hot. This latter fact has suggested use in production-line metal coating.

Three more flexible epoxy resins have also been announced by Dow Chemical. They are x-2673.2, x-2673.6 and x-2674. These resins are described as light-colored, low-viscosity fluids which may be blended with common liquid and solid epoxies, and with Dow Epoxy Novolac 438. They are cured with all common hardeners. According to Dow technical spokemen, flexure strength can be increased 25 to 40% by the addition of the new resins. Shock resistant castings and adhesives, laminates, and coatings are areas of expected application.

Coating for automotive trim

Car wheel covers and other automotive trim can now be protected against scratching, rust, and corrosion for a year or more by applying coatings based on Vitel polyester made by The Goodyear Tire & Rubber Co. The material, produced in resin or pellet-like form, can be made into a clear or tinted liquid solution that forms a hard glossy protective film which, it is claimed, adheres well to chrome, aluminum, steel and other metals.

Irradiated polyolefins

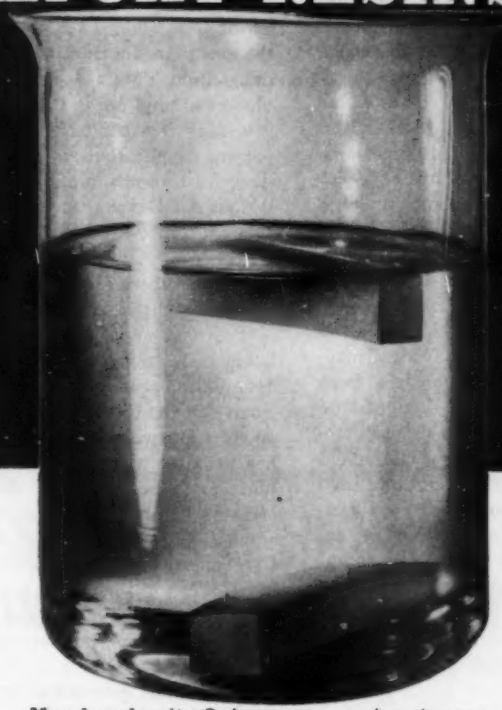
Latest in a growing list of companies supplying irradiated plastics, Mimx Corp., Glendale, Calif., is now offering a line of irradiated polyolefin shapes to the missile, space, aircraft, and other industries. Using standard polymers from normal commercial sources and compounding them to its own requirements, the company irradiates extrusions, moldings, or thermoforms made from these compounds with a 2-m.e.v. General Electric beam generator.

Typical properties of irradiated compounds are: tensile strength—2500 p.s.i.; ultimate elongation—150%; flexibility and freedom from cracking down to —55° C.; freedom from cracks and splits, and maintenance of form stability, after exposure to 175° C. for 96 hr.; no evidence of melting, loss of form stability, or structural integrity after 4 hr. at 250° C.; and resistance to Skydrol 500, aviation gasoline of 100/130 octane, hydrocarbon solvents, and other materials used in aviation.

Typical applications include grain inhibitors for rocket propellants, coverings for capacitors and other steady state devices, and rocket engine igniter coverings. Investigations are currently being conducted by the company concerning the feasibility of using Mimx materials as re-entry shields for nose cones.

SHRINKABLE TUBING. Availability of a new irradiated polyolefin tubing and sleeving material which can be heat shrunk in diameter to form a tight bond, even over irregular shapes, has been announced by Sequoia Wire & Cable Co., a subsidiary of Anaconda Wire & Cable Co., New York, N. Y. Flame retardant and thermally stable, the new flexible tubing, designated as Hyshrink, can be slipped easily in its expanded form over terminals, connectors, wire and cable, conduit, and hose, according to

NEW OXIRONS WEIGH LESS, GO FURTHER THAN CONVENTIONAL EPOXY RESINS



◀ OXIRON BAR FLOATS, CONVENTIONAL EPOXY SINKS IN ORGANIC LIQUID

New low density Oxiron epoxy resins give you structural components with **high strength-to-weight** ratios. They **keep weight to a minimum** in critical applications such as encapsulated electronic assemblies for aircraft and missiles. Oxirons give you the **most coverage** area from every pound of epoxy in your coating formulations. With Oxiron epoxy resins you can accomplish all these things, because the hardened resins have **10 to 20% lower density** than conventional epoxies! And thanks to the extra quantity of product obtainable from each pound of Oxiron epoxy, an **economic gain** is often possible. Where weight must be kept down, Oxirons may well be the answer for applications such as missile and aircraft parts, molds, tools and fixtures, radome panels, transformers and motors, potted electronic components, printed circuits, as well as for general structural laminate use.

OXIRONS ARE DIFFERENT

Oxirons are epoxidized polyolefins. Unlike conventional epoxies, Oxirons can be cured through reactive double bonds as well as multiple epoxy groups present in the chain.

MORE ADVANTAGES

OXIRONS exhibit low shrinkage on cure.

OXIRONS can be cured at relatively low temperatures.

OXIRONS can often be cured with low cost reagents.

OXIRONS provide superior resistance to creep at elevated temperatures.

OXIRONS can be cured with anhydride-peroxides to give materials characterized by heat distortion curves that do not break sharply with temperature.

OXIRONS have excellent electrical properties and stability at high temperatures.

OXIRONS offer high strength, powerful adhesion, good wetting-out properties.

OXIRONS have excellent chemical resistance—are unaffected by strong alkalis, acids, solvents.

Send for our Epoxy Data Booklet which describes Oxiron 2000, 2001, and 2002 in detail, contains curing information and gives suggested uses. If you'd like a sample, let us know what application you have in mind so that we can supply a suitable resin.

Putting Ideas to Work

fmc

FOOD MACHINERY AND CHEMICAL CORPORATION

Epoxy Department

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EPOXIDES CURRENTLY AVAILABLE FROM FMC

OLEFIN OXIDES: Octylene Oxide, Dodecene Oxide, C16-C18 Olefin Oxide.
TERPENE OXIDES: Limonene Monoxide, alpha-Pinene Oxide.
DIEPOXIDES: Dicyclopentadiene Dioxide, Limonene Dioxide.

THE PLASTISCOPE

(From page 224)

the company. Upon application of heat (275° F.), the tubing shrinks in diameter to form a strong mechanical bond to the insert. This heating will not affect the flexibility of the irradiated tubing. Longitudinal shrinkage is reported to be less than 10 percent.

New U. S. subsidiary

Ornapress AG, Zurich, Switzerland, pioneer in the development of foils for decorative molding in either urea or melamine, has established American Ornapress Corp., 16 E. 42nd St., New York, N. Y., a wholly-owned subsidiary. Stephen Bayer is in charge of the operation as vice-president and general manager. The company has announced a technique for decorating phenolics; details of this process will be made public shortly.

Stocks nylon rods

Massive nylon rods in diameters from 3 to 9 in. are now stocked nationally by the 15 warehouses of Cadillac Plastic & Chemical Co., Detroit, Mich. Available for overnight delivery to most U. S. destinations, in standard lengths up to 10 ft., the rods may be obtained in unlimited lengths upon special order. The large-diameter rods are expected to be used in the petroleum and chemical industries for valve facings and components in transmission lines where corrosion and abrasion have been problems. The material is being produced at Cadillac's plant in the Detroit suburb of Warren.

Polycarbonate tubing

Extruded polycarbonate tubing, made of General Electric's Lexan resin, is now available from Anchor Plastics Co., Long Island City, N. Y. custom extruder, in diameters from 0.040 to 1½ in., and wall thicknesses from 0.015 to 0.125 inch.

Vinyl foam adhesive

Tradenamed Bondmaster R379-20, a "soft seam" adhesive has been developed by Rubber & Asbestos Corp., Bloomfield, N. J., especially for bonding closed-cell vinyl foam to itself, to vinyl film or sheet, to phenolic and other plastics, and to metal, wood and other rigid, semi-rigid, or flexible materials. With "quick grab" for fast assembly speeds, it may be brushed on, roll coated, or sprayed on with regular equipment. It is said to resist salt water, high humidity, vibration, hot oil, gasoline, aromatic fuels and organic solvents, and prolonged exposure to temperatures between 250 to 350° F. A strong bond is formed on contact, according to the company.

Acrylic lenses

Extruded acrylic lenses in small to medium size for non-critical magnification are now available from Anchor Plastics Co., Long Island City, N. Y. In industrial and commercial applications where slight aberrations are not important, such as on designation strips, magnifiers, indicators and nameplates, an extruded lens will be more economical than an equivalent molded one and the extruded lens (tooling $100 to $300) can be supplied by Anchor in any length without additional tooling.

More foam core panels

While municipal building codes continue to stymie full application of styrene foam in building construction, the material is gradually making inroads in locales that are not controlled.

For example, foam core building panels have been adapted for the first time to the farm building field by Wood-Fab Inc., Lester Prairie, Minn., by the use of their Dri-Lite panels. The panels, which are surfaced with either plywood or fibreboard, have a foam core of Dylite expandable polystyrene, a product of the Plastics Div., Koppers Co. Inc., Pittsburgh, Pa.

In another development, 60 Dylite panel houses are also planned for construction on the outskirts of Juneau, Alaska, as part of a 2000-home project on a 457-acre site. Stone & Schulte Inc., San Jose, Calif., and its associate builders, Blackwell Brothers, is handling the project, first of its kind in Alaska.

High-modulus glass fiber for structural plastics

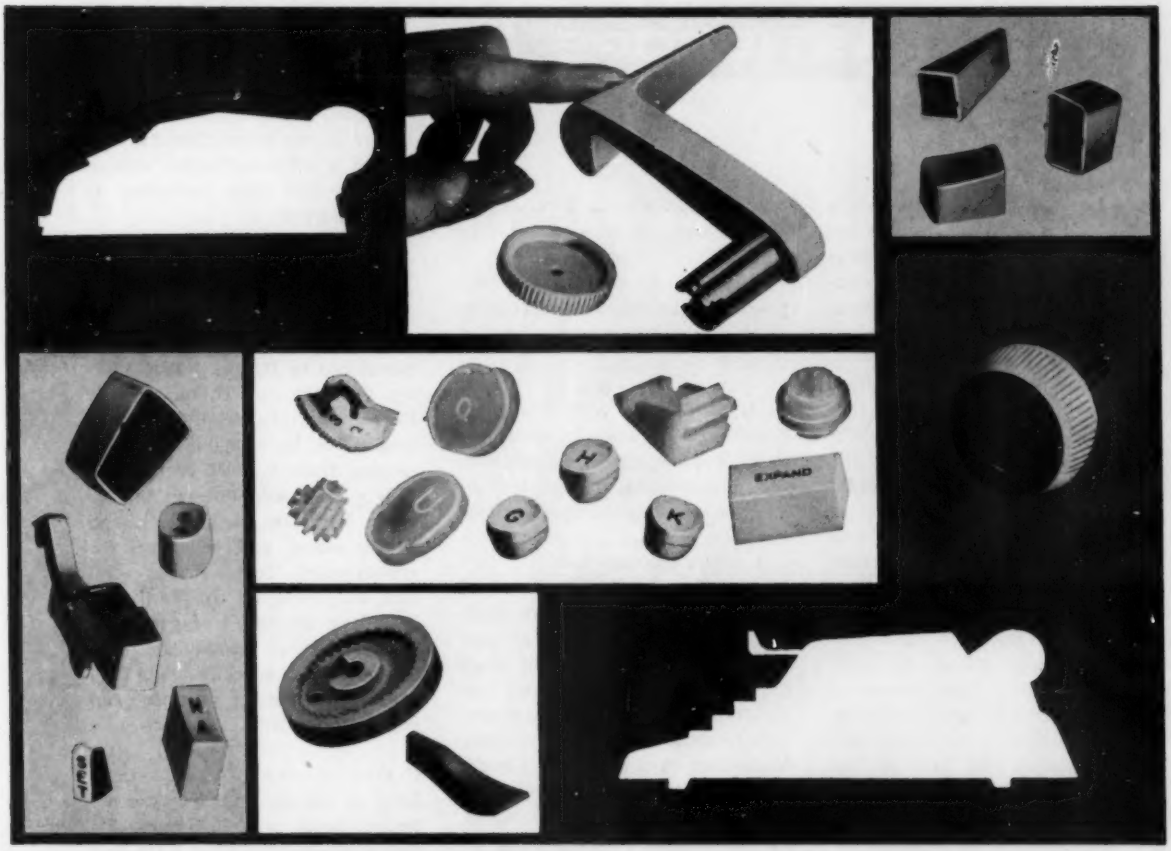
Glass fibers said to have about 50% greater rigidity than E-glass fibers (generally used as plastics reinforcement) without significant sacrifice in strength, have been developed for the U. S. Air Force by Owens-Corning Fiberglas Corp. Standard E-glass has a modulus of elasticity of about 12.2×10^6 p.s.i.; the new glass, introduced under the designation YM-31-A, has a modulus of around 16×10^6 p.s.i. The new fiber is expected to have important application in structural uses. Test results reported by the Wright Air Development Div. indicate the following:

1. YM-31-A-based laminates are generally superior to E-glass laminates in strength.
2. Strength properties of such laminates depend greatly on the resin-finish combination. To date, Epon 828-CL (Shell Chemical Co.) epoxy resin with an A-1100 finish has been the most successful combination to be used with the new glass evaluated.
3. YM-31-A fibers look particularly promising for filament-winding applications since their performance will exceed E-glass even when used with non-optimum resin-finish combinations.
4. Electrical properties of YM-31-A are only slightly inferior to E-glass in the lower temperature ranges, but in the 300 to 500° C. range, rapid changes in electrical properties would make YM-31-A unsuitable for such applications as radar guidance.

Full details and test data were published in the Proceedings of the Meeting on High Modulus Glass Fibers for Structural Application. Copies of the Proceedings are available from G. P. Patterson, WWRC-NC-2 WADD, Wright-Patterson Air Force Base, Ohio.

Polyethylene news

HIGHER CROP YIELDS. A double layer of PE film consisting of a sheet of black polyethylene, which is laid down and lightly covered with loose soil, and a thinner layer



STOKES HIGH-SPEED INJECTION MOLDING PRESSES earn big savings for Smith-Corona Marchant

With the aid of Stokes Injection Molding Presses, Smith-Corona Marchant is turning out from one-half to three-quarter million dollars worth of parts per year for typewriters, adding machines, calculators, teletypewriters, and other products.

Complete sets of typewriter and calculator keyboards are produced at the rate of 400 to 440 per hour by the four Stokes Model 703 Automatic Injection Molding Presses shown here. These versatile Stokes presses are used for both multi-color and metal-insert molding.

Key to these high production rates is Stokes nozzle shut-off and full pressure prepack design. This exclusive design feature reduces the production cycle by having the injection plunger and precompressed material ready to shoot into the mold the moment the press is closed.

Stokes vertical clamping system permits loading of inserts without the danger of their falling out during the molding operation. Unusually high clamping capacity gives full and complete closure so that no flash is formed on the insert part. Independently actuated knock-out pins provide slow, gentle ejection without reducing clamping ram speed.

Discover for yourself what Smith-Corona Marchant and other leading manufacturers have found to be the many cost and quality advantages of Stokes Injection Molding Presses. Write for Bulletin 203 which gives complete details on the Stokes Model 701 and 703. Be sure to ask for a Stokes production analysis on your particular application requirements.

Plastics Equipment Division

F. J. STOKES CORPORATION

5500 Tabor Road, Philadelphia 20, Pa.

STOKES

THE PLASTISCOPE

(From page 226)

of clear film of the same width which is simultaneously laid on top and anchored by covering the sides with soil, produces markedly superior yields than black PE alone. This new method of using PE film mulch was described by Dr. E. M. Emmert, Professor of Horticulture at the University of Kentucky.

The increased yield was attributed to an earlier warming of the soil in the spring than was possible to achieve by the use of black film alone. The double film also assisted in moderating hot weather temperatures. Black will absorb more heat from the sun in the daytime, but will lose heat faster at night than colored materials. When the sun is shining, the clear film allows the warmth of the sun to pass through and be absorbed by the black film which transmits the heat to the soil. At night, however, when the black film would normally lose its heat rapidly to the atmosphere, the clear film has trapped an insulating layer of air which holds the soil heat, thus speeding germination and growth, according to Dr. Emmert's report.

The double mulch brought crops to harvest one week earlier than the single mulch and approximately three weeks earlier than unmulched crops. This method, therefore, enables the grower to market his produce at the peak of prices. The tests at the University's experiment station were run on cucumbers, sweetcorn, tomatoes, bunch beans, pole beans, and lima beans. A part of Dr. Emmert's work is supported by a research grant from Union Carbide Plastics Co.

FOR PROTOTYPES. A line of linear PE blocks intended for the production of prototype bearings, automotive parts, molds for various casting type resins, laboratory and hospital wear, etc., is now available from American Agile Corp., Maple Heights, Ohio. The material is machinable with standard woodworking or machine tools and equipment; and prototypes may be autoclaved repeatedly at 250° F. with no bad effects, according to the company. Stock sizes are 1 by 12 by 12 in., weighing 4.9 lb., to 6 by 12 by 24 in., weighing 58.8 pounds. Prices range from $12.25 to $126.42 per block, depending on the size.

FILM ON FLOWER POTS. Peat moss flower pots, manufactured by Willis-Reynolds Corp., Lebanon, Ind., incorporate a 1-mil film of PE which is said to impart greater durability, restrain root penetration and reduce moisture loss.

According to U. S. Industrial Chemicals Co., the pots are made by first preparing a slurry of peat moss and wood fiber. Molds made of perforated metal are dipped into the slurry and the material is drawn into the mold by suction. Pots thus formed are then dried in an oven. This dried pot temporarily becomes the die during vacuum forming of the PE film. The high porosity of the pot facilitates this operation and the vacuum is drawn right through the pot. When it is time for permanent planting the polyethylene which is formed tightly to the outside of the flower pot must be removed to permit ready growth of the roots into the surrounding soil. Willis-Reynolds states that it can produce 2½ million pots—ranging in size from 1½ to 4 in. deep—per week, in round or square shapes.

WIDER SHEETS. Gering Plastics Div., Studebaker-Packard Corp., Kenilworth, N. J., now offers 10-mil-thick PE sheeting measuring 20 by 100 ft., seamless, in natural-clear and black. These heavy-gage sheetings are expected to find use as silage covers, industrial coverings, and closing-in of structures.

ALSO FOR TREES. Preliminary tests at the Union Carbide Corp. Research Farm in Clayton, N. C., have shown significant increases in tree growth through the use of black PE film mulch around the base of the tree. If present results are confirmed in a broadscale testing program, it will mean that home owners can radically shorten the time required for shade trees to grow to pleasing proportions. For nurserymen it will mean larger, stronger plants that command higher market prices. For the fruit grower it will mean larger, sturdier trees in less time, according to Union Carbide.

NEW RETAIL UNIT. Black and natural polyethylene films in 4- and 6-mil thicknesses in take-home dispenser type packages have been introduced by Plastics Films, Visking Co., Div. of Union Carbide Corp. The rolls, each 50 ft. in length, will be available in widths ranging from 3 to 20 feet. These rolls will be sold through lumber yards, hardware, department, and variety stores, and will retail for approximately 2¢/sq. ft. for 4-mil film, and 3¢/sq. ft. for 6-mil film. This type of unit is expected to replace sales of custom sheet for air conditioner covers, wading pool liners, shrubbery protectors, and garden tool covers.

CURING BLANKET. A 2-in. thick layer of fibrous glass encased between sheets of 8-mil black PE film is suppled by Max Katz Bag Co. Inc., Indianapolis, Ind. It is supplied in 6 ft. width and up to 50 ft. in length, as a re-usable insulating blanket for concrete curing. The PE film is supplied by Visking Co., Div. of Union Carbide Corp.

New companies

JORDAN-NATIONAL CO., PTY. LTD., Sydney, Australia, is a newly formed company jointly owned by NATIONAL STARCH & CHEMICAL CORP. and JORDAN CHEMICAL WORKS (A'SIA) PTY., LTD., Sydney. The new firm will manufacture and sell vinyl polymers and various adhesives made in the United States by National Starch & Chemical.

UNIVERSAL PACKAGING INC., Mill and Buchanan Sts., Plainfield, Ind., is a packaging firm specializing in packaging of liquids, semi-liquids, and solids in all heat-sealable, flexible materials. DAVID G. REILICH is president; ARLIE S. RIGGS serves as vice-president.

IMPERIAL ADHESIVES INC., located in a new 25,000-sq.-ft. plant at

Counterpoise, by Steuben Glass

For Achievement: The Owens-Corning Fiberglas Design Award*

The classic crystal sculpture shown here, designed and executed by Steuben Glass, is entitled *Counterpoise*. Each year, at the conference of The Society of The Plastics Industry, it will be awarded to a company for the best use of Fiberglas reinforced plastics in a new product. An impartial jury, appointed by The Society, will determine the winning product on the basis of originality of application or design, material selection, color, utility, moldability and appearance. The manufacturer of the product will receive the Owens-Corning Fiberglas Design Award, *Counterpoise*, as well as The Society's Gold Ribbon. This year's inaugural presentation will be made on February 8, at The Society's annual banquet during the meeting in Chicago.

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FIBERGLAS

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SYNTHETIC RESINS

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In dry form, Lucidol Benzoyl Peroxide has long been the quality standard of the industry. It is available, for those who prefer it, in wet form (20-25% water). The peroxide net weight per package is the same. The applications are identical — polymerization of vinyl acetate, vinyl chloride, vinylidene chloride, methylmethacrylate, styrene and unsaturated polyesters — and for copolymerizations of the same monomers.

Write for Data Sheet or Consult Chemical Materials Catalog Page 179 for further data.

LUCIDOL DIVISION

WALLACE & TIERNAN INC.
1740 MILITARY ROAD
BUFFALO 5, NEW YORK

THE PLASTISCOPE

(From page 228)

6315 Wiehe Rd., Cincinnati, Ohio, is engaged in production of latex and solvent compounds. JERRY CONRAD, formerly technical director of Adhesive Products Corp., is president; STEVE PROOPS, previously general manager of Anchor Adhesives Corp., is vice-president.

Expansion

THE BORDEN CHEMICAL CO. (CANADA) LTD. has announced construction of new manufacturing facilities for the production of polyvinyl acetate emulsions, polystyrene and acrylic emulsions, and liquid urea resins. The expansion program, involving an investment of $250,000, includes a recently completed warehouse building. All products produced in Canada by the company are for Canadian consumption.

FABRI-KAL CORP. has broken ground for a 23,000-sq.-ft. plant in Kalamazoo, Mich. The building, scheduled for completion early in 1961, will be used for the manufacture of custom and proprietary sheet plastic products.

MOLDED FIBER GLASS BODY CO., Ashtabula, Ohio producer of reinforced plastic parts and assemblies for automotive and allied fields, and MOLDED FIBER GLASS TRAY CO., Linesville, Pa., have announced a merger, with Molded Fiber Glass Body Co. as the surviving corporation.

ACTION PLASTICS INC., and its parent company, COLORITE PLASTICS OF NEW JERSEY, INC., both extrusion firms, have announced acquisition of a 22,500-sq.-ft. building next to their present operating plant in Paterson, N. J. The new building brings total manufacturing area to 67,000 sq. ft., plus storage buildings of 20,000 sq. feet.

MONSANTO CHEMICAL CO. has announced plans to construct a new plant which will add 50 million lb. to its production capacity for Santicizer 160 plasticizer. At the same time, the company will erect a 20-million-lb./year facility for the production of benzyl chloride, an

ingredient of Santicizer 160. Both units will be located at the company's 650-acre plant site in Gloucester County, N. J., where the company earlier announced plans for a phthalic anhydride plant. Completion of all three units is scheduled for 1962.

AMOCO CHEMICALS CORP. is expanding its Joliet Ill., dimethyl terephthalate plant to increase capacity by 50 percent. Estimated construction time for the new manufacturing facilities is 10 months. Dimethyl terephthalate is used as an intermediate in the manufacture of polyester films and fibers.

UNIVIS INC., formerly Univis Lens Co., has moved from Dayton, Ohio, to its newly constructed 100,000-sq.-ft. plant in Fort Lauderdale, Fla. Univis produces plastic lenses and frames for ophthalmic and industrial uses, hearing aids, and plastic components for the Armed Forces.

GEAUGA INDUSTRIES, Middlefield, Ohio, has completed a 32,000-sq.-ft. building to house a completely automated production line for transfer-molded parts as well as a new laboratory. Geauga Industries, a subsidiary of THE CARLISLE CORP., Carlisle, Pa., now occupies a total of 135,000 sq. ft., and employs 350 persons.

RARITAN PLASTICS CORP., Paterson, N. J., producer of heavy-gage plastic sheet, plans to construct a 20,000-sq.-ft. building on a 20-acre plot in Oakland, N. J. The new plant, scheduled for completion during the early part of 1961, will initially employ approximately 40 people. General offices and all production facilities of the company will move from the present location in Paterson to the new site.

POLY-ACRYLS, a division of R. A. CHEMICAL CORP., Brooklyn, N. Y., has begun production of acrylic resins for paper, leather, paint, and textile applications in a new plant and laboratory which occupy two 40-ft.-high buildings. The first resin reactor went on stream in October, and additional reactors will be installed in the near future. The process is semi-automatic and controlled so that reproducible emul-

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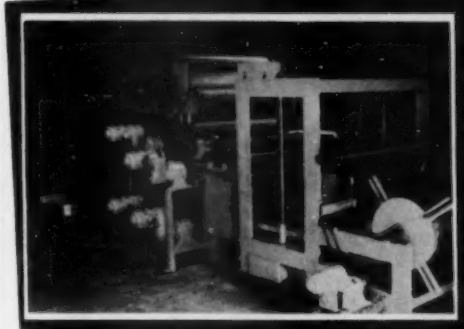

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WITH VALLEY PRINT UNIT and/or GRAVURE PRINTING HEAD
in tandem

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- Surface Prints two colors, Embosses and Laminates in 1 operation
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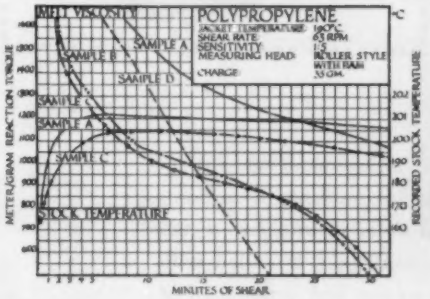

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- Effect of Each Additive
- Decomposition Factors
- Temperature-Viscosity Relationship
- Production Rates

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THIS NEW STUDY contains the inside story of one of America's fastest growing industrial markets. It presents one of the most stimulating and detailed analyses of the plastics field that has yet been published. It's filled with up-to-date figures on the consumption and production of plastics materials, on the field's processing equipment requirements, on potential areas of growth. It lists hundreds of kinds of machines, accessories, chemicals and intermediates, supplies and special services for which the field is manifesting an ever-increasing appetite.

You will find this handsome brochure—file size, lavishly illustrated, 40-pages—a valuable addition to your business library. It may well point the way to increased sales for the industrial products or services that your firm supplies.

For your free copy of "The Plastics Field," simply address a note on your company letterhead to *Advertising Director*, Modern Plastics, 575 Madison Avenue, New York 22.

THE PLASTISCOPE

(From page 231)

sions can be manufactured. The laboratory has a pilot plant equipped with a 5-gal. stainless steel resin reactor in which all of the pilot runs were made. New resins developed by the R & D department will be piloted in the 5-gal. reactor prior to production. The plant and laboratory are under the supervision of C. L. MICHAUD, technical director.

FEDERAL TOOL CORP., Lincolnwood, Ill., has completed a merger with PROVEN PRODUCTS INC., and FEDERAL PREMIUM SERVICE INC., both of Skokie, Ill. The new organization, named FEDCO CORP., will operate the following divisions: FEDERAL HOUSEWARES, FEDERAL TOOL & DIE, PROVEN PRODUCTS, and FEDERAL MOLDING & STAMPING. J. G. TOBIN, president of both Proven Products and Federal Premium Service Inc., is Fedco president; R. M. WILLETS is director of sales of all divisions.

PLASTI-LINE INC., Knoxville, Tenn., producer of outdoor illuminated plastics signs, has announced an addition of 75,000 sq. ft. of production space to its present 130,000-sq.-ft. plant. Cost of the new plant, including newly-purchased automatic processing equipment is estimated at $100,000.

LASCO INDUSTRIES INC., producer of plastic pipe and translucent building panels, has consolidated its multi-plant operation in a new 54,000-sq.-ft. building on 4½ acres in Montebello, Calif. The facility, completed at a cost in excess of $500,000, excluding equipment, provides double the floor space and four times the production capacity of the two former plants.

NOPCO CHEMICAL CO., Newark, N. J., has broken ground in Chattanooga, Tenn., for construction of a 70,000-sq.-ft. polyether urethane foam plant. The facility, with a designed capacity of 4 million lb./year, is expected to be in operation by the spring of 1961.

CONSOLIDATED PIPE CO. OF AMERICA INC., Akron, Ohio, has acquired the entire pipe *(To page 235)*

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molding and extrusion materials that break through the price-performance barrier!

LUSTRAN A NEW FAMILY OF MOLDING AND EXTRUSION MATERIALS

Take an existing product made with a common material, redesign and produce it with Lustran, and you will create a new product made with fewer pieces, little or no finishing, less labor, and at far lower cost than previously thought possible. You will have a product with an amazing combination of light weight, unusual toughness and durability. And it will have the sales appeal to help you increase volume—profitably.

Take that development product that's on the drawing board or the one that hasn't quite gelled in your mind . . . Lustran is the material to make these ideas come alive and earn profits. Or perhaps Lustran is the material needed to spark that elusive new product idea.

What is Lustran? Lustran is a unique composition of styrene and other monomeric materials produced by using an entirely new concept of molecular arrangement. It employs an advanced polymerization technique to meet the higher requirements of more applications more efficiently than ever before. Whether your product requires components that run two hundred to the pound or ten pounds each, Lustran is the material for rugged performance and profit improvement.

What are its properties? Lustran is so versatile that it can be formulated to meet a broad range of physical, chemical and price requirements. Lustran has a unique combination of effective strength, rigidity, and other desirable properties to a significantly high degree. One Lustran formulation, for example, has 4 times the impact resistance of rubber modified styrene, 10 times that of general purpose styrene. Lustran has exceptional impact and tensile strength, a vast color range, rigidity, abrasion and chemical resistance as well as efficient, economical processability. Products made with Lustran have excellent surface appearance, hardness and gloss. You can drive nails or turn screws into Lustran. At zero degrees Fahrenheit, a ⅛ inch thick 24 inch square sheet withstands the shock of 25 foot pounds. Under an 800 pound load, an automotive armrest made of Lustran remains intact while the supporting metal screws fail.

What are the uses for Lustran? Lustran has been successfully injection molded into parts weighing as much as 3½ pounds and vacuum formed in deep drawn parts weighing up to 11 pounds. It will find great demand in products which require high impact strength, rigidity, and breakage resistance in addition to the traditional important advantages of plastics . . . built-in color, corrosion resistance, single-piece construction. Lustran promises new developments in design and cost savings for new products, components and housings for business machines, automobiles, refrigerators, air conditioners, fans, radios, television, vacuum cleaners and other appliances, housewares, shoes, packages, pipe fittings and toys. Wherever performance and cost are critical, Lustran will find application.

What are its processing characteristics? Plastics converters who have worked with Lustran have been astonished at the superior thermal stability of Lustran. Over a wide range of temperatures, it is possible to produce components with excellent uniformity in color and physical properties . . . performance not always achieved with other styrene polymers. With Lustran you can achieve consistent color control even in softest pastels. It can be molded and extruded in standard equipment. Sheets of Lustran can be formed, fabricated, and decorated using conventional techniques.

Can you capitalize on this development now? Lustran is now available from interim production facilities which can meet anticipated commercial requirements. A fifty million pound plant is now under construction. It will be in operation the latter part of 1961. With the addition of the Lustran family of plastics to our familiar Lustrex styrene molding materials, Monsanto now supplies the broadest spectrum of styrene based materials.

An extensive program has been set up to acquaint plastics converters with the unique capabilities and business building opportunities of Lustran. Plastics converters are invited to contact the nearest Monsanto sales office for more information. Designers and manufacturers are invited to write for current data and progress reports to Monsanto Chemical Company, Plastics Division, Dept. 803, Springfield 2, Massachusetts.

LUSTRAN, LUSTREX: Reg. U. S. Pat. Off.

Monsanto

MONSANTO INNOVATOR IN **PLASTICS**

THE PLASTISCOPE

(From page 232)

fittings division of GULF STREAM PLASTICS INC., Hialeah, Fla., and has moved the equipment to the injection molding division of Consolidated in Akron.

FLO-TRONICS INC., Minneapolis, Minn., manufacturer of electronic controls, materials-handling systems, and plastic products for industry, has acquired RUBBER INDUSTRIES INC. and PLASTICOS CO. through an exchange of stock. Rubber Industries will operate as a wholly-owned subsidiary and will continue under direction of DONOVAN P. STERN, president. Plasticos' business and production facilities will be integrated into Flo-Tronics' present PLASTICS DIV. under SYLVESTER MADY, vice-president of manufacturing for the division.

BEMIS BRO. BAG CO. has acquired a controlling interest in AIR-FORMED PRODUCTS CORP., Nashua, N. H. blowmolding firm, and a substantial interest in THE SYSTEMATION CORP., Chesterfield, Mo. firm specializing in development of integrated and automated packaging systems and machinery.

DIAMOND ALKALI CO. is constructing a multi-million dollar acetylene plant at its Deer Park, Texas installation which will supply all acetylene required for manufacture there of Diamond's polyvinyl chloride plastics. The new acetylene plant will be based on a process developed by MONTECATINI, SOCIETA GENERALE PER L'INDUSTRIA MINERARIA E CHEMICA, Milan, Italy. Completion is scheduled for late 1961.

PIPE LINE SERVICE CORP., subsidiary of AMERICAN STEEL FOUNDRIES, has started construction of a 94,000-sq.-ft. pipe-coating plant in Youngstown, Ohio. The plant is located on a 39-acre site and will initially employ about 50 persons. Completion is scheduled for about April, 1961.

According to F. C. YEAZEL, president, Pipe Line Service has also signed an agreement with REPUBLIC STEEL CORP. under which the company will coat pipe with X-Tru Coat, a Republic-developed process of continuous extrusion of a high-density polyethylene jacket held to the steel pipe by a pressure-sensitive adhesive.

DU PONT CO. is constructing a plant at Buffalo, N. Y., for manufacture of Teslar polyvinylfluoride film. The plant will be operated as a unit of the YERKES FILM PLANT, which now manufactures PE film, Vexar plastic netting, and cellophane. Operations at the new plant are expected to start in mid-1962. The plant will employ about 200.

PREMIUM VACUUM PROCESS CORP., Maspeth, N. Y., custom vacuum metallizer, has completed a new one-story addition to its plant which doubles former manufacturing space and increases plant capacity by 40 percent.

BARNETT J. DANSON & ASSOCIATES LTD., Toronto, Canada distributor of plastics machinery and accessories, is constructing a new building in Toronto near Highway 401. The building will provide office and showroom space, warehouse facilities, and a library containing technical publications, directories, etc.

Deceased

Maurice C. Bachner, 74, a co-founder of *Chicago Molded Products Corp.*, died Nov. 12, after an extended illness. Mr. Bachner headed the company as president for 20 years, and was chairman at the time of his retirement in 1944.

Meetings

Plastics groups

Jan. 24-27: Society of Plastics Engineers Inc. (S.P.E.) Baltimore-Washington Section, 17th Antec, Shoreham Hotel, Washington, D. C.

Feb. 7-9: S.P.I. 16th Reinforced Plastics Div. Conference, Edgewater Beach Hotel, Chicago, Ill.

Feb. 8: S.P.E. Newark Section, Extrusion Professional Activities Committee, Military Park Hotel, Newark, N. J.

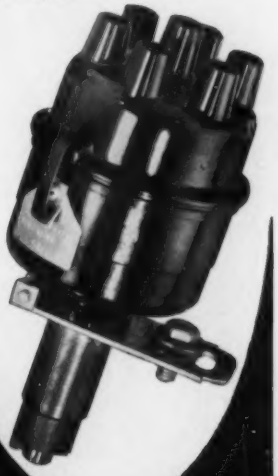
April 12-14: Deutsche Kunststoff-Tagung, Berlin, Germany.

June 5-9: S.P.I. 9th National Plastics Exposition and National Plastics Conference, Coliseum and

example...

FIBERITE

Reinforced phenolics at work...



for ELECTRIC AUTOLITE distributor bowls

Electric Autolite of Toledo needed a plastic molding compound for ignition distributors in automotive and industrial engines. The molded part must maintain rigid dimensional tolerances under very adverse conditions of temperature and humidity. Autolite specified Fiberite No. X-2414 cotton fiber reinforced phenolic. Here is Autolite's report:

1 Dimensionally stable
2 Impact resistant
3 Heat resistant
4 Corrosion resistant
5 Light weight
6 Easily machined

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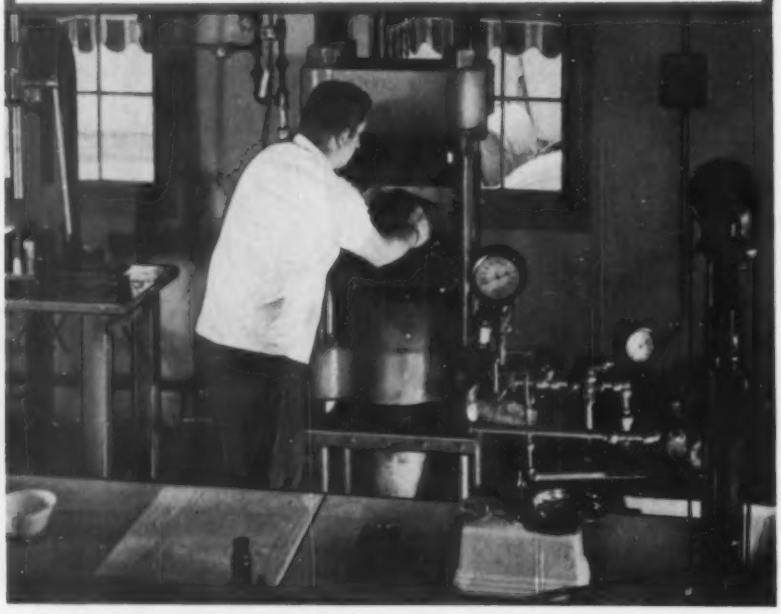

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From impact-testers to X-ray, our well staffed laboratory is equipped to maintain strict quality control over molding compounds and production molding. Here, too, under laboratory surveillance, we still tailor our own Neillite — one of the first phenolic molding compounds — to your specific needs. On numerous occasions, Government Agencies have retained us to design, develop and test applications and materials.

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THE PLASTISCOPE

(From page 235)

Commodore Hotel, New York, N. Y.

June 9-17: European Congress of Chemical Engineering ACHEMA Congress and Exhibition, Frankfurt am Main, Germany. Simultaneously, and in the same city, 15th Meeting of European Federation of Corrosion.

June 16-25: Europlastica 1961, Palais des Floralies de Grand, Ghent, Belgium. For additional information, write: M. G. Honnet, 40 Rue du Colisée, Paris 8e, France.

June 21-July 1: Interplas 61, 6th International Plastics Exhibition and Convention, Olympia, London.

July 27-Aug. 1: International Symposium on Macromolecular Chemistry, Queen Elizabeth Hotel, Montreal, Canada.

Other groups

Jan. 29-Feb. 2: National Assn. of Home Builders 17th Annual Convention and Exposition, McCormick Place, Chicago, Ill.

Feb. 3: Akron Polymer Lecture Group, "Some Aspects of Anionic Polymerizations," Room 107, Knight Hall, University of Akron, Akron, Ohio.

Feb. 19-28: IPACK Biennial International Packing and Packaging Exhibition, Milan, Italy.

Feb. 20-23: Technical Assn. of the Pulp & Paper Industry (TAPPI) 46th Annual Meeting, Hotel Commodore, New York, N. Y.

Feb. 26-Mar. 1: American Institute of Chemical Engineering, 1st A.I.Ch.E. Petrochemical and Refining Exposition, Municipal Auditorium, New Orleans, La.

March 7: TAPPI program, "The Development of Plastics as a Packaging Medium," Chicago Bar Assn., Chicago, Ill.

Mar. 27-31: 3rd National Symposium on "Temperature—Its Measurement and Control in Science and Industry," jointly sponsored by American Institute of Physics, Instrument Society of America, and National Bureau of Standards, will be held in Columbus, Ohio.—*End*

TRY THIS with other so called "non-dusting" dry color pigments! Ferro's latest improvement in such materials for plastic molders has vastly *superior adherence* to resin granules— *all* granular thermoplastic resins.

Available in any color, Ferro's non-dusting pigments improve color dispersion, eliminate troublesome dusting (often the cause of color contamination), facilitate the use of pneumatic devices for the transfer of the resin-colorant mixture from tumbling drums to hoppers.

These are things that can save you money, cut production costs. Try Ferro's new *non-dusting* pigments. Prove the big difference, yourself!

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Color Division

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Plants in Canada and t... foreign nations

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Appointments, promotions, and relocations in the plastics industry.

Hooker Chemical Corp., Niagara Falls, N. Y.: **Dr. J. Howard Brown** appointed mgr., research; **Robert F. Schultz,** mgr., process development; **Dr. Alvin F. Shepard,** sr. scientist. **Dr. Marion B. Geiger** appointed dir., international development, and he has been transferred to New York, N. Y. headquarters.

Cadillac Plastic & Chemical Co. established new sales offices in Toledo and Dayton, Ohio. **John Stamm** is mgr. at Toledo; **Phillip Latshaw** is mgr. at Dayton.

Premier Vacuum Process Corp., Maspeth, N. Y. custom vacuum metallizer: **Leonard Bloom** formerly of Ideal Toy Corp., appointed chief engineer. **Leonard Greenfield** joined the firm as sales mgr.

Monsanto Chemical Co.—Plastics Div., Springfield, Mass.: **Theodore S. Klein** and **Bernard J. Patnode** joined the production tech. service dept; **Roy E. Miller** joined the research dept.; **Joseph P. Orr,** public relations asst., assigned to St. Louis, Mo., central public relations group.

Allied Chemical Corp.—Plastics Div. appointed these product mgrs.: **John J. Taylor,** polyethylene; **Stanley M. Mulder,** Plaskon phenolic resins; and **David W. Towler,** Halon fluorohalocarbon compounds.

Plastic Food Container Assn., Chicago, Ill., composed of mfrs. of injection-molded and vacuum-formed food containers, elected the following officers at its 2nd annual meeting: **W. S. Pinkerton, Neatway Products Inc.,** Minneapolis, Minn.—pres.; **W. R. Cline, Mutual Plastic Mold Corp.,** S. Gate, Calif.—v-p.

American Cyanamid Co.: Dan J. O'Conor Jr., pres. of **Formica Corp.,** elected a v-p of the parent company, responsible for Formica Corp. and Cyanamid's Plastics & Resins Div., Wallingford, Conn. **Walter A. Smith,** named exec. v-p of Formica Corp.

Society of the Plastics Industry, New York, N. Y.: **Dr. Samuel Steingiser,** asst. dir. of research, **Mobay Chemical Co.,** and **Edwin A. Edberg, Dylite Foam Dept., Koppers Co. Inc.,** reelected chrmn. and v-chrmn., respectively, of the **Cellular Plastics Div.** of the society.

Rogers Corp., Rogers, Conn. producer of fiber-and-plastic materials for industrial, consumer, and military applications: **Frank P. Welsh, Albert M. Ankrom,** and **Robert E. Sanders** named field engineers in Baltimore, Md.; St. Louis, Mo.; and Northern Ohio, respectively.

Spencer Chemical Co.—Plastics Div., Kansas City, Mo.: **D. L. Duncan** named polyethylene product mgr.; **James Doti,** mgr., tech. information and evaluation; **Glenn Tolle,** supv., tech. service; **Sam Manci,** product improvement supv.; and **C. B. O'Connell,** mgr., plastics sales, Kansas City dist.

Pam-Pro Plastics, fabricator of precision plastics parts, moved its mfg. and office facilities from Redwood City, to new and larger quarters at 1075 O'Brien Dr., Menlo Park, Calif.

Kaye-Tex Mfg. Corp., Yardville, N. J. mfr. of Vyflex calendered vinyl for auto interior trim, swimming pool liners, luggage, etc., established new sales offices at 329 Fifth Ave., New York, N. Y.

Phillips Chemical Co.—Plastics Sales Div.: G. M. Tucker, formerly sales rep., Chicago, Ill. office, transferred to Kansas City, Mo. area; **C. E. Johnson** appointed sales engineer, Chicago dist.; and **K. L. Smalley,** named sales engineer, Detroit, Mich.

Continental-Diamond Fibre Corp., Newark, Del., Central R & D Laboratories: **Karel J. J. Brouwers** named research specialist, polymer research section; **Richard B. Goodrich** appointed research engineer, fibre research section.

U. S. Industrial Chemicals Co., Div. National Distillers & Chemical Corp.: Paul J. LaMarche named v-p, production. **Polymer Service Laboratories** promotions: **Donald W. Pugh** appointed to newly created position of staff asst., special services; **Dr. Alfred B. Zimmerman,** asst. group leader, applications development group; **Lawrence E. Dowd** and **Joseph F. Pilaro** named group leaders, customer services groups; **Richard J. French** and **Charles J. Wolfenberger** named asst. group leaders, plant asst. group; **Ray C. Wulliman** appointed asst. group leader, special developments group.

Union Carbide Plastics Co., Div. Union Carbide Corp.: Robert M. Lewis, Thomas F. Regan, and **David L. Leonard** assigned as tech. reps., New York sales region. They will be located at the company's Clifton, N. J. office.

Air Reduction Co. Inc., New York, N. Y., has consolidated its three chemical divs., **Air Reduction Chemical Co., Colton Chemical Co.,** and **National Carbide Co.,** into a new div. known as **Air Reduction Chemical & Carbide Co.** Officers of the new div. are: **G. R. Milne,** pres.; **B. R. Krashin,** v-p, marketing; **R. T. Lund,** v-p, operating; **R. A. Speck,** v-p, distribution; and **J. M. Timnon,** v-p, engineering.

Jet Plastics, Los Angeles, Calif., established a new extrusion operation under the name **Bay Plastics,** in S. San Francisco. **Johnnie Johnson** is pres.; **Ulrich Sellau** is plant mgr.

U. S. Rubber Co.: Earle S. Ebers designated group v-p, responsible for operations of the company's textile, plantation, and **Naugatuck Chemical Divs.** as well as **Latex Fiber Industries Inc.,** a subsidiary. **Dudley Chittenden** elected a v-p of the company and appointed gen. mgr., **Naugatuck Chemical Div. Dr. Clide I. Carr** named mgr., synthetic fiber research dept., and **Harry S. Witt** appointed mgr. plastics research dept. **Russell W. McIntosh** has joined the company's **Kralastic** sales department.

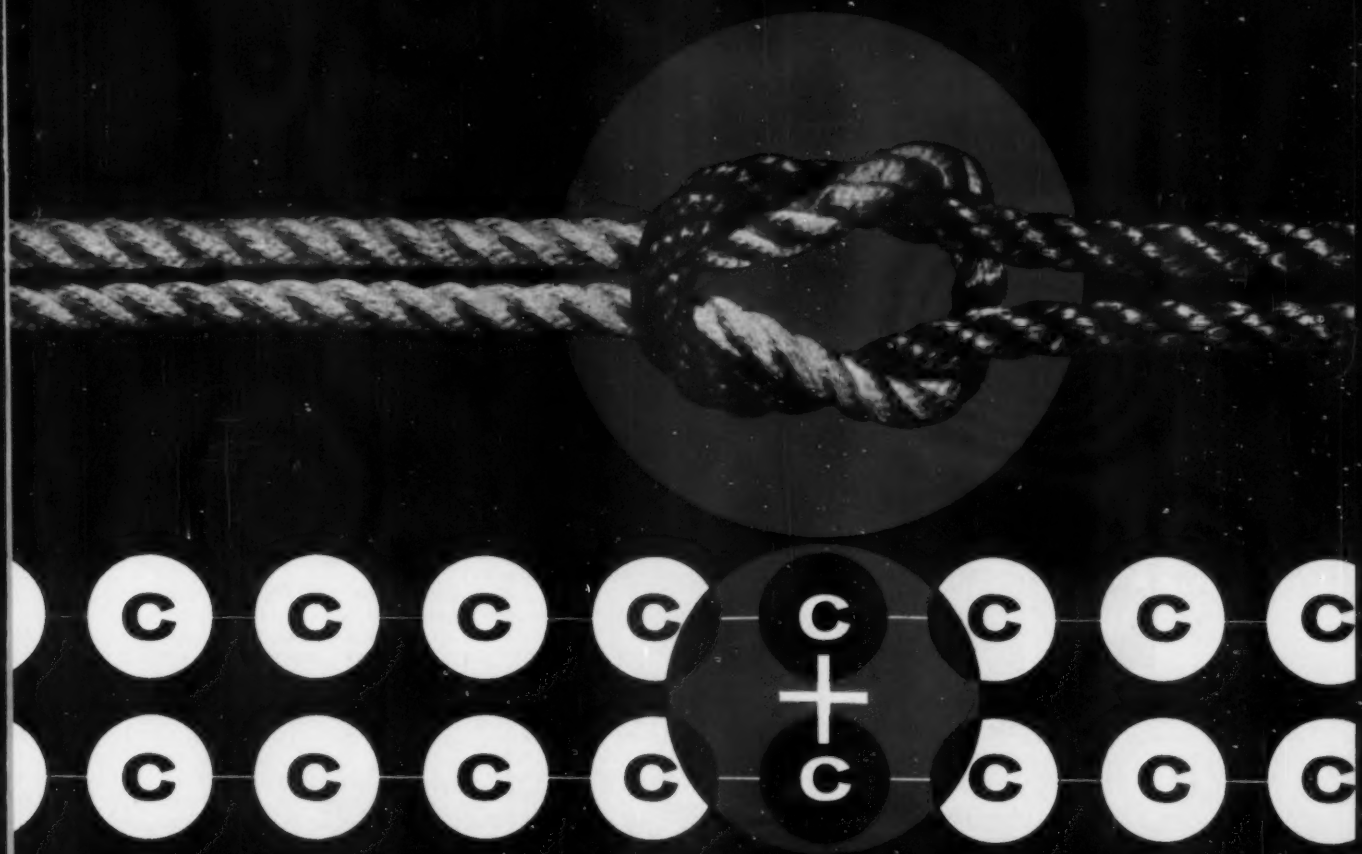
Cabot Corp., Boston, Mass. producer of chemicals and carbon black: **Dr. Robert W. Cottingham** joined the organic and polymer research section, new products research dept. **Dr. Robert D. Beattie** appointed to newly created position of polyolefins project mgr.

AviSun Corp., Marcus Hook, Pa. producer of polypropylene polymer, film, and fiber: **Edgar E. Wrege** appointed administrative asst. to **Pres. Herschel H. Cudd. Charles A. Borda** and **Daniel J. Lyons** named sales reps. for the firm's Olefane polypropylene packaging film.

Celanese Plastics Co., div. of **Celanese Corp. of America,** has leased a plant in Alta Loma, Calif. for production of blow-molded polyethylene containers for packaging detergents as well as other household and industrial items.

Foam-Flex Corp., New York, N. Y. has licensed **Urethane Systems Engineering Inc.,** Willow Grove, Pa., to make machines that will produce in continuous form rigid urethane foam sandwich panels and flexible cushioning materials that are produced by the Foam-Flex process.

Filon Plastics Corp., Hawthorne, Calif. mfr. of reinforced plastic panels: **Frank Malone** appointed to newly created position of regional sales mgr., Southern Calif. territory; **Vaughn Monsell** named Southern Div. sales mgr., **(To page 240)**



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Di-cup, Hercules dicumyl peroxide, is a source of free radicals, which are highly effective in chemical cross-linking. It provides a simple, economical, and practical means of cross-linking low-density polyethylene.

Cross-linked polyethylene is a thermoset material resistant to softening and deformation at high temperatures. It shows no evidence of environmental stress cracking and it is resistant to many solvents at high temperatures.

This development opens new markets for products that require superior toughness, flexibility, impact strength, and chemical resistance.

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instrumentation for most

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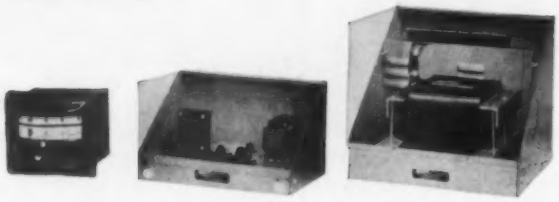
NOW UNIVERSAL:

controls the most unstable temperature systems

Gardsman by WEST | **Model JSB Stepless Controllers**



For any operation requiring precise control of any temperature, through electric heaters, money can't buy a finer instrument. *Infinitely* modulates heater power. No on-off pulses; prolongs heater-life and saves power. Now provided with exclusive manual switch and adjustable maximum and minimum input control. *Tubeless.* Compact. Requires least maintenance and operating attention.

The most compact programming system available includes Model JSBG (left) for any operation involving a time-temperature cycle. Its simply cut cams integrate and control time with temperature.

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COMPANIES...PEOPLE

(*From page 238*)

with headquarters in the Atlanta, Ga. district office.

Koppers Co. Inc.—Plastics Div.: **H. C. Lavely** appointed mgr., plastics applications; **W. J. Fitzgerald,** national account mgr.; and **W. J. Gort,** product mgr., Dylite expandable polystyrene.

Cooke Color & Chemical Co., Hacketstown, N. J., inaugurated a Flying Color Laboratory, an airplane technical service for plastics and rubber industries. The lab will be headed by **Edwin Zabowski.**

S. Leon Kaye, formerly of **Kaye Plastics Corp.,** Edison, N. J., has retired from manufacturing activities and is now a plastic consultant at 158 Maple Ave., Metuchen, N. J.

Fred R. Barlow appointed v-p, sales and marketing div., **Plastic Materials & Polymers Inc.,** Garden City, N. Y.

Jack G. Fuller, formerly gen. mgr., Chemtrol Div., Rexall Drug & Chemical Co., named national sales mgr. for **Ankerwerk International** and **Krauss-Maffei International.** The two companies, with offices in Bound Brook, N. J., and Santa Ana, Calif., represent the West German parent organizations, manufacturers of reciprocating screw-plasticating injection molding machines. Mr. Fuller will operate initially from Santa Ana.

Robert W. Weaver elected pres. of **Cadillac Plastic Co. of Mo.,** succeeding **John C. Lake,** who resigned.

Ray H. Mulford elected exec. v-p. **Owens-Illinois Glass Co.** He will have management responsibility for the Closure & Plastic Div., Pacific Coast Div., and Glass Container Div.-East.

Corrections

"And in Brief," (MPI, Oct. 1960, p. 178): Cold-headed stainless steel inserts for molding into plastics parts are supplied by C.S.M. Screw Products Co., Chicago, Ill., which makes them from stainless supplied by The Carpenter Steel Co.

"Breakthrough in mold making—Electro-erosion" (MPI, Dec. 1960, p. 111): Photograph for Fig. 6 was inadvertently printed upside down.

"Behavior of plastics in re-entry environments, Part 2," (MPI, Dec. 1960, p. 147): Equation 18 should read

$$H_{eff} = \frac{C_p \Delta T + h_{ib} + f(Y_L \Delta H)}{1 - (q_r/q_o)}$$

The phrase "high surface tension" in Conclusion 3 on page 198 should read "low surface tension."—*End*

HOBBS CENTER-SHAFT
WEB WINDING & UNWINDING DRIVES

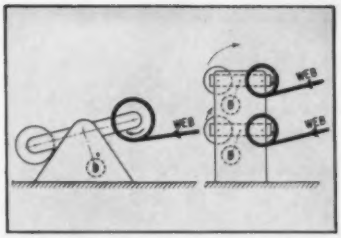


Fig. 1 — Diagram illustrating layout of two-shaft and four-shaft turret winders

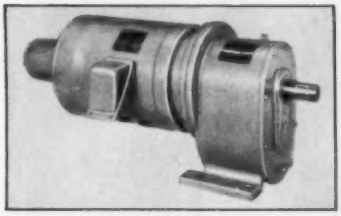


Fig. 2 — Hobbs Standard CHP Winding Drive

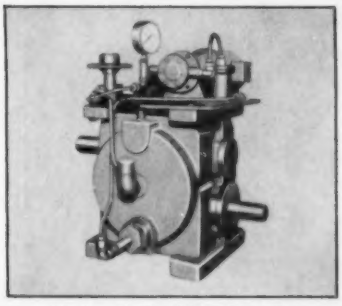


Fig. 3 — Hobbs APF Progressive Friction Winding Drive

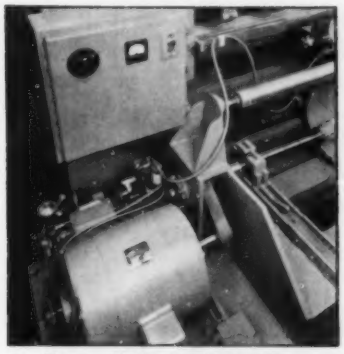


Fig. 4 — Hobbs HG Unwind Drive

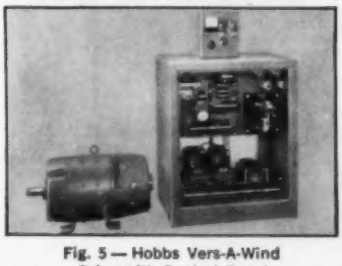


Fig. 5 — Hobbs Vers-A-Wind Drive with Control Panel

872-0

9 Types from which to Choose

Hobbs Center-Shaft Winding (see Fig. 1) is superior to surface drive winding, because it makes it possible to wind and to control tension, without friction on the surface of the material. Thus the possibility of abrasion or distortion is avoided and a roll with maximum usability or salability is assured. The various types of Hobbs drives for web winders and unwinders and their adaptability are described herewith.

HOBBS STANDARD CHP WINDING DRIVE (Fig. 2)
Preset tension is automatically maintained through the torque-speed characteristic of a constant horsepower A. C. motor. The latter slows down as the diameter of the roll increases. Its torque output increases proportionally, maintaining essentially constant H. P. — the equivalent to constant tension. May be stalled 100%. Also supplied for tapered tension. Ratio of speed change and diameter buildup as high as 1:30.

HOBBS NTJ WINDING DRIVE WITH SYNCHRONIZATION
Preset tension maintained during frequent speed changes through a 3-phase synchronizing generator, driven by main machine. Speed of generator varies with that of main machine. Frequency of output current and speed of motor varies accordingly, resulting in essentially constant tension. Unit has higher ratio of speed change and diameter buildup than standard unit, a ratio of 1:100 being obtained on some material.

Typical applications of the CHP and NTJ include calendering, coating, embossing, flexographic printing, inspecting, laminating, plastics.

HOBBS APF PROGRESSIVE FRICTION WINDING DRIVE (Fig. 3)
Preset tension automatically maintained with extreme accuracy, during a roll buildup of 8:1, through a series of overriding friction clutches running in oil. Driven from the main machine, winder changes speed in proportion and still maintains constant tension. Required torque increase is sensed directly from the web. For use with calenders, coaters, dampening machines, laminators, slitters and waxers.

HOBBS HG UNWIND DRIVE WITHOUT SYNCHRONIZATION (Fig. 4)
Tension is maintained through the torque-speed characteristic of the unit, which closely approaches constant horsepower. As the diameter of the roll decreases, the r.p.m. increases and the braking torque decreases. Hence the tension on the material remains essentially constant. Tension is adjusted by controlling the current. Used where process speeds are constant and where the unwind roll is up to speed before the HG Unwind is energized.

HOBBS HG UNWIND DRIVE WITH SYNCHRONIZATION
Designed for applications requiring stop-start and speed changes during operation. Eliminates need for manual control. A saturable reactor with necessary bias and signal control is used for synchronization. A tach generator, driven from the process machine, generates current for the reactor, which increases as the speed increases. From zero to full speed, the supply current is controlled from near zero to almost full. Once tension is set by a control knob, no further adjustment is required.

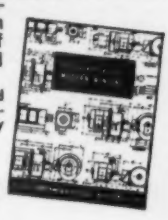
Hobbs HG Unwind Drives are used with coaters, dampeners, laminators, printing presses, friction calenders, slitters, etc.

OTHER DRIVES INCLUDE...
— Hobbs DCS Vers-a-wind Speed Control Drive (Fig. 5), Hobbs DCT Vers-a-wind Tension Control Drive, Hobbs DCTA Vers-a-wind Tension Control Drive and Hobbs DCTS Vers-a-wind Tension Control Drive. Description on request.

AIR AND MECHANICAL BRAKES
For unwind applications, alternate air or mechanical brakes can be furnished for automatic or manual control of unwind tension.

WINDING ACCESSORIES INCLUDE...
— web guides, castered bases, mandrels, "Center-Loc" core holders, conventional core chucks, special core chucks, and slitting attachments.

ALSO COMPLETE WINDING MACHINES, INCLUDING...
— light, medium and heavy duty single shaft; medium and heavy duty two-shaft staggered; medium and heavy duty three-shaft staggered; medium duty four-shaft staggered; two-shaft cantilevered fixed shaft and turret; light, medium and heavy duty two-shaft turret; heavy duty two-station shaftless turret; light and medium duty four-shaft duplex turret, and heavy duty three-shaft turret. Type of winding drive used is selected on basis of process specifications and application.



LITERATURE • The complete line of Hobbs Center-Shaft Web Winding and Unwinding Drives and Hobbs Winding Machines is described and illustrated in "Principles and Practices of Modern Winding". Send for a copy free of all obligations.

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Help Wanted

PLASTIC DESIGN ENGINEER WANTED —Growing company, engaged in the manufacture of quality plastic molds, has opening for highly qualified plastic mold designer. Excellent opportunity for advancement. Suburban location north of Chicago. Contact Charles Zapf & Co., 2423 Main St., Evanston, Illinois.

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(*Continued on page 244*)

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(*Continued from page 242*)

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ATTENTION POLYESTER MANUFACTURERS—I want to handle technical service and/or sales for a resin manufacturer. Experience includes production, sales and market development. Reply Box 6788, Modern Plastics.

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PLASTICS ENGINEER—I am seeking a challenging management position in manufacturing and/or engineering, where my broad background in reinforced plastics, and thermoplastic and thermoset coatings, is useful. I am 35 years old, and have almost completed MS requirements in chem. engineering. A detailed resume will be furnished upon request. Reply Box 6807, Modern Plastics.

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PRODUCTION MANAGER—Chem. Engr. graduate, 35, with 9 yrs. experience in engineering and production of molded parts, particularly matched metal molding of reinforced plastic, desires responsible position in production. Knowledge of time study, estimating, prod. control and labor relations. Reply Box 6790, Modern Plastics.

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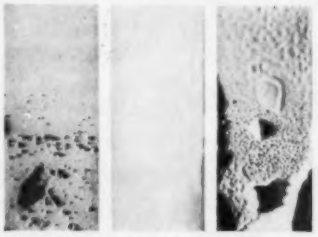

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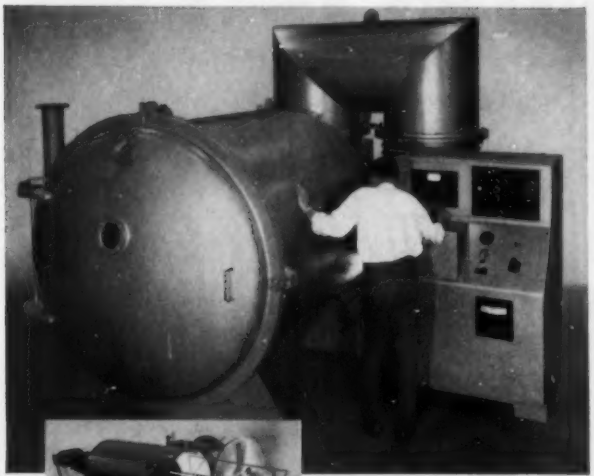

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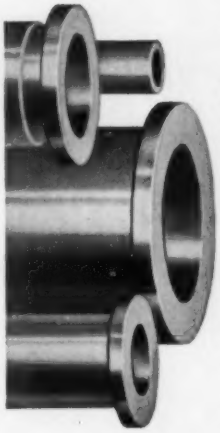

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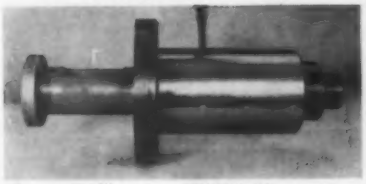

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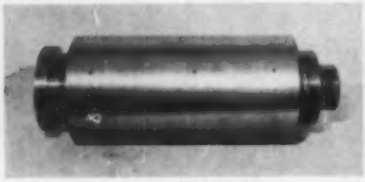

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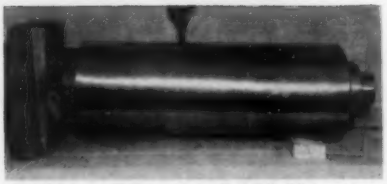

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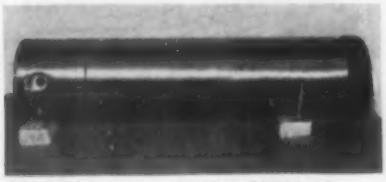

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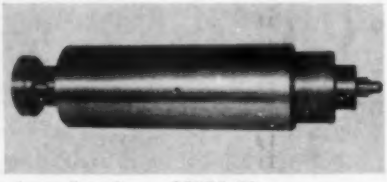

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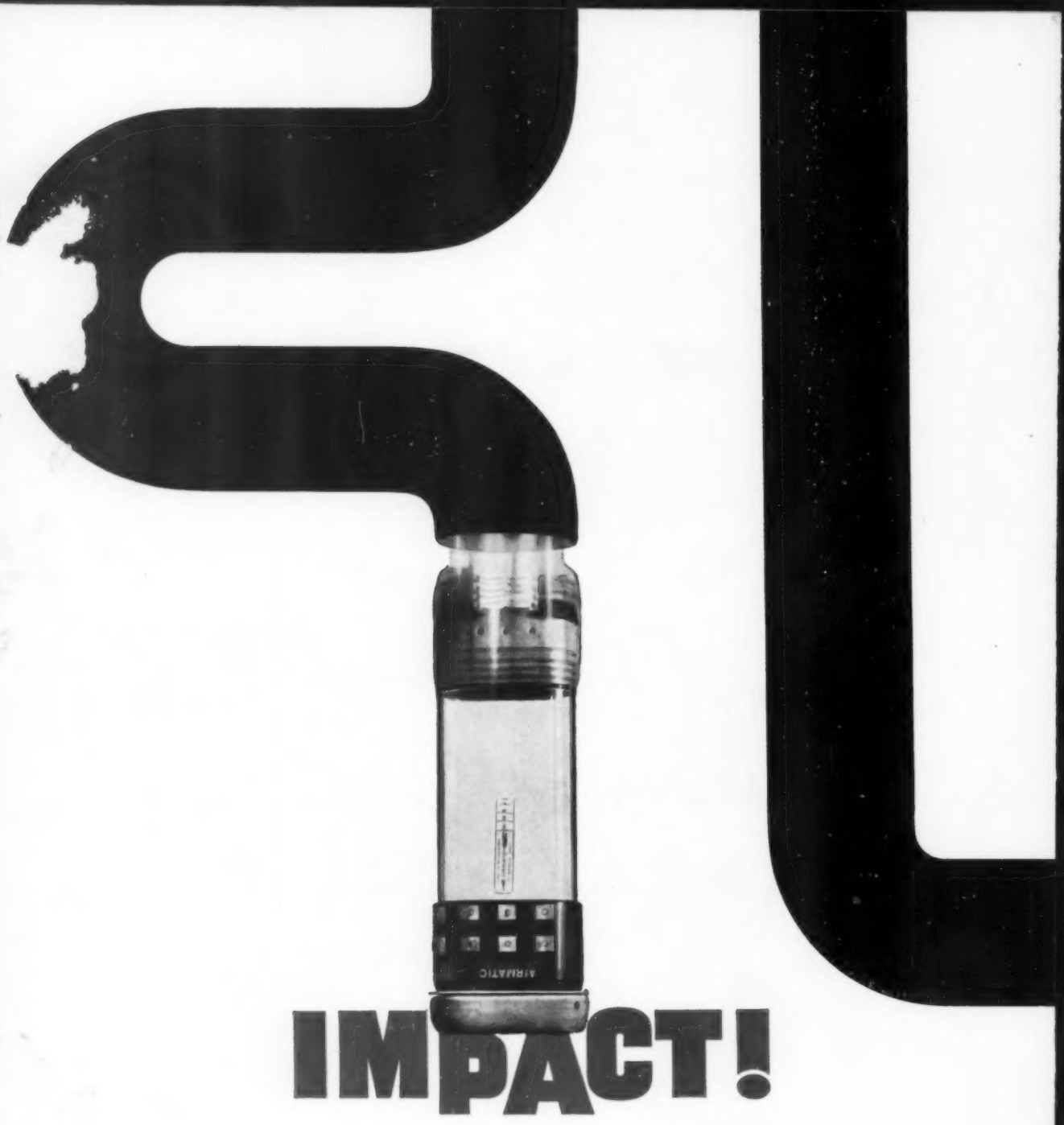

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